Los Angeles

DISTRIBUTED DISTRICT ENERGY:
A POTENTIAL CATALYST FOR EQUITABLE URBAN DECARBONIZATION

TECHNICAL ASSISTANCE PANEL REPORT | OCTOBER 2022

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CenTrioCenTrio Energy, with financial support from a generous gift from Owen Thomas to the ULI Foundation

ON THE COVER: Bunker Hill, Downtown Los Angeles, California

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Panelists tour the CenTrio central plant facility on Bunker Hill.

ABOUT

About the Urban Land Institute

The Urban Land Institute is a global, member-driven organization comprising more than 45,000 real estate and urban development professionals dedicated to advancing the Institute's mission of shaping the future of the built environment for transformative impact in communities worldwide. ULI's interdisciplinary membership represents all aspects of the industry, including developers, property owners, investors, architects, urban planners, public officials, real estate brokers, appraisers, attorneys, engineers, financiers, and academics. Established in 1936, the Institute has a presence in the Americas, Europe, and Asia Pacific region, with members in 81 countries. ULI's extraordinary impact on land use decision-making is based on its members' sharing expertise on a variety of factors affecting the built environment, including urbanization, demographic and population changes, new economic drivers, technology advancements, and environmental concerns. Peer-to-peer learning is achieved through the knowledge shared by members at thousands of convenings each year that reinforce ULI's position as a global authority on land use and real estate. Drawing on its members' work, the Institute recognizes and shares best practices in urban design and development for the benefit of communities around the globe.

More information is available at uli.org. Follow ULI on Twitter, Facebook, LinkedIn, and Instagram.

About ULI Los Angeles

As the preeminent, multidisciplinary real estate forum, ULI facilitates the open exchange of ideas, information, and experience among local, national, and international industry leaders and policymakers dedicated to creating better places. A district council of the Urban Land Institute, ULI Los Angeles is a nonprofit education and research institute with more than 1,900 members in the Greater Los Angeles area. As a nonpartisan organization, ULI has long been recognized as one of America's most respected and widely quoted sources of objective information on urban planning, growth and development. The membership of ULI-LA represents the entire spectrum of land use and real estate development disciplines. They include developers, builders, investors, architects, public officials, planners, real estate brokers, appraisers, attorneys, engineers, lenders, academics and students.

ULI District Council Leadership

Allison Lynch
President, Watt Companies
Council Chair, ULI Los Angeles

Marty Borko
Executive Director, ULI Los Angeles

ULI Advisory Services: National & Global Programs

Since 1947, the ULI Advisory Services program has assembled well over 700 ULI-member teams to help sponsors find creative, practical solutions for complex land use challenges. A wide variety of public, private, and nonprofit organizations have contracted for ULI's advisory services. National and international panelists are specifically recruited to form a panel of independent and objective volunteer ULI member experts with the skills needed to address the identified land use challenge. The program is designed to help break through obstacles, jump-start conversations, and solve tough challenges that need an outside, independent perspective. Three- and five-day engagements are offered to ensure thorough consideration of relevant topics.

An additional national offering is the project analysis session (PAS) offered at ULI's Fall and Spring Meetings, through which specific land use challenges are evaluated by a panel of volunteer experts selected from ULI's membership. This is a conversational format that lends itself to an open exchange of ideas among diverse industry practitioners with distinct points of view. From the streamlined two-hour session to the "deeper dive" eight-hour session, this intimate conversational format encourages creative thinking and problem solving.

Learn more at americas.uli.org/programs/advisory-services.

ULI Advisory Services identify creative, practical solutions for complex land use and development challenges.

Technical Assistance Panels Program (TAP)

In keeping with the Urban Land Institute mission, Technical Assistance Panels are convened to provide pro-bono planning and development assistance to public officials and local stakeholders of communities and nonprofit organizations who have requested assistance in addressing their land use challenges.

A group of diverse professionals representing the full spectrum of land use and real estate disciplines typically spend one day visiting and analyzing the built environments, identifying specific planning and development issues, and formulating realistic and actionable recommendations to move initiatives forward in a fashion consistent with the applicant's goals and objectives.

ULI Net Zero Imperative

Thanks to a generous gift from Owen Thomas, ULI has launched the Net Zero Imperative—a multi-year initiative to accelerate decarbonization in the built environment. Additional gifts from Lynn Thurber, Joe Azrack, Franz Colloredo-Mansfeld and Dan Cashdan further support and bolster the NZI program's scale and impact. Work to advance the initiative includes technical assistance panels in five global cities each year, designed to help developers, building owners, cities, and other relevant constituents reduce carbon emissions associated with buildings, communities, and cities. The fundamental goal of the effort is to provide concrete ideas and strategies to real estate owners, public sector leaders, and the general public to eliminate carbon emissions from the built environment to reach net zero. Through its work, the initiative will create global resources (research, toolkits, and other tools) to help all ULI members accelerate decarbonization in their real estate operations and in their cities.

Technical Assistance Panel and Project Staff

Panel Co-Chairs

Marty Borko
Executive Director, ULI Los Angeles

David Hodgins
Executive Director, LA Better Buildings Challenge
Founder & CEO, Sustento Group

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Photographer, KE Photo

"Angels Flight" originally opened on Bunker Hill in 1901 to take passengers between Hill Street and Grand Avenue.

EXECUTIVE SUMMARY

The Assignment: A Roadmap to Net Zero

ULI's Los Angeles District Council partnered with the LA Better Buildings Challenge (LABBC), IBI Group, Arup and CenTrio Energy to identify real-world strategies to develop a "distributed district energy system" in Downtown Los Angeles, beginning with a central plant located in the heart of the Bunker Hill neighborhood.

Objectives

- Identify strategies to enhance and expand an existing district cooling plant to serve additional buildings.
- Identify strategies to scale impact by connecting the existing plant to additional district plants in Downtown Los Angeles, creating a "distributed district energy system" that enhances efficiency and resilience for multiple diverse property types and the system as a whole.
- Identify strategies to enable smaller, less well-resourced buildings to connect to the district system.
- Create a replicable roadmap for other cities to leverage existing infrastructure toward city, regional and global decarbonization efforts.

The work conducted for this ULI Net Zero Imperative project marks the beginning of a long-term on-the-ground campaign.

Key Questions

ULI Los Angeles asked the technical assistance panel (TAP) to consider the following four themes:

1. Technical Potential

What opportunities are there for the Bunker Hill central plant to generate and store energy, while balancing loads across a decentralized, distributed system?

- How can existing chilled water infrastructure assets be leveraged to balance loads across various use types and support decarbonization efforts?
- What types of existing and potentially available space can be leveraged to expand the system and generate or store energy?
- How can district and building-level plant infrastructure assets be leveraged to optimize district-wide energy demand and optimize equipment capacity and efficiency?

2. Private Market Buy-In

Given that private property owners traditionally prefer to own and maintain building-level utility plants, how could a Bunker Hill distributed district energy system generate private sector buy-in?

- How can the system address concern regarding potential disruption events at both the building level and system-wide level?
- How can the system address concern around operational control, particularly in tenant-occupied buildings or buildings currently utilizing forced air systems?
- How can load balancing be leveraged to increase energy supply and cost reliability, and reduce greenhouse gas intensity?

3. Engagement, Incentives & Financial Models

How can innovative collaboration models unlock opportunity between public and private sector stakeholders?

- What are the benefits of a distributed district energy system and what are the potential costs to receive those benefits and services?
- How do utility rates and rate structures impact the financial viability of energy storage and other projects?
- What types of support are needed to facilitate multilateral project development conversations, and which organizations are best positioned to provide that?

4. Social Impact & Equity

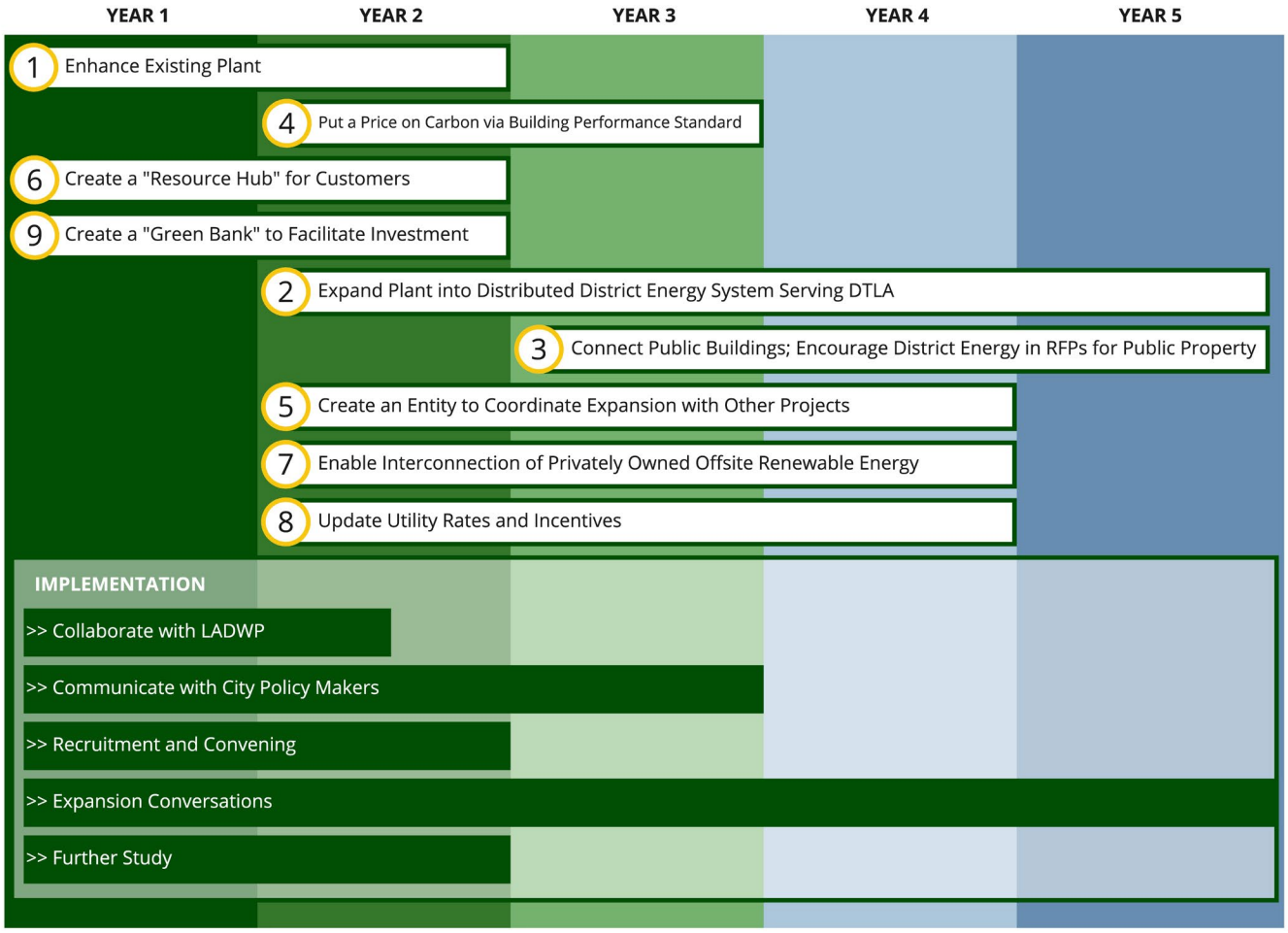
How could a distributed district energy system generate positive social impact in the project area and elsewhere in the city?

- How can the city encourage and enable smaller buildings to access the system?
- How can the distributed district energy system align with existing and emerging financing models to support deeper investment in low-income communities?
- What are best practice frameworks to source, vet and quantify the potential social impacts?

Major Conclusions & Recommendations

The goal of the Bunker Hill technical assistance panel was to find ways to expand the existing district energy system in the Bunker Hill community in a way that would optimize cost and the reduction of greenhouse gas emissions across multiple property types and uses. While this report focuses on CenTrio's Bunker Hill plant, the panel's recommendations are meant to be scalable, to apply not only to other plants in Los Angeles, but also more broadly across the country and around the world.

1. **Enhance the Existing Bunker Hill Plant:** Improve resilience, efficiency and environmental performance to attract additional customers.
2. **Expand the System:** Connect strategically located satellite plants to serve additional neighborhoods and realize environmental, social and operational co-benefits.
3. **Connect Public Buildings:** Catalyze expansion of the system by connecting public buildings and encouraging connection of redevelopment projects on public land.
4. **Put a Price on Carbon:** Develop a building performance standard to spur investment.
5. **Create an Entity to Coordinate Expansion:** Realize cost and time efficiencies by coordinating expansion with other infrastructure projects.
6. **Create a Resource Hub:** Provide free technical assistance to help customers modernize their buildings and connect to the system.
7. **Enable Interconnection of More Renewable Energy:** Incentivize customers to coinvest in pursuit of 100% clean energy goals.
8. **Update Utility Rates to Support Energy Storage:** Incentivize customers to deploy thermal and battery storage.
9. **Create a Green Bank:** Facilitate public, private, and philanthropic co-investment through a local nonprofit green bank.
10. **Take Action:** Connect with stakeholders to move important conversations forward.


YEAR 1
YEAR 2
YEAR 3
YEAR 4
YEAR 5
1 Enhance Existing Plant
4 Put a Price on Carbon via Building Performance Standard
6 Create a "Resource Hub" for Customers
9 Create a "Green Bank" to Facilitate Investment
2 Expand Plant into Distributed District Energy System Serving DTLA
3 Connect Public Buildings; Encourage District Energy in RFPs for Public Property
5 Create an Entity to Coordinate Expansion with Other Projects
7 Enable Interconnection of Privately Owned Offsite Renewable Energy
8 Update Utility Rates and Incentives
IMPLEMENTATION
>> Collaborate with LADWP
>> Communicate with City Policy Makers
>> Recruitment and Convening
>> Expansion Conversations
>> Further Study

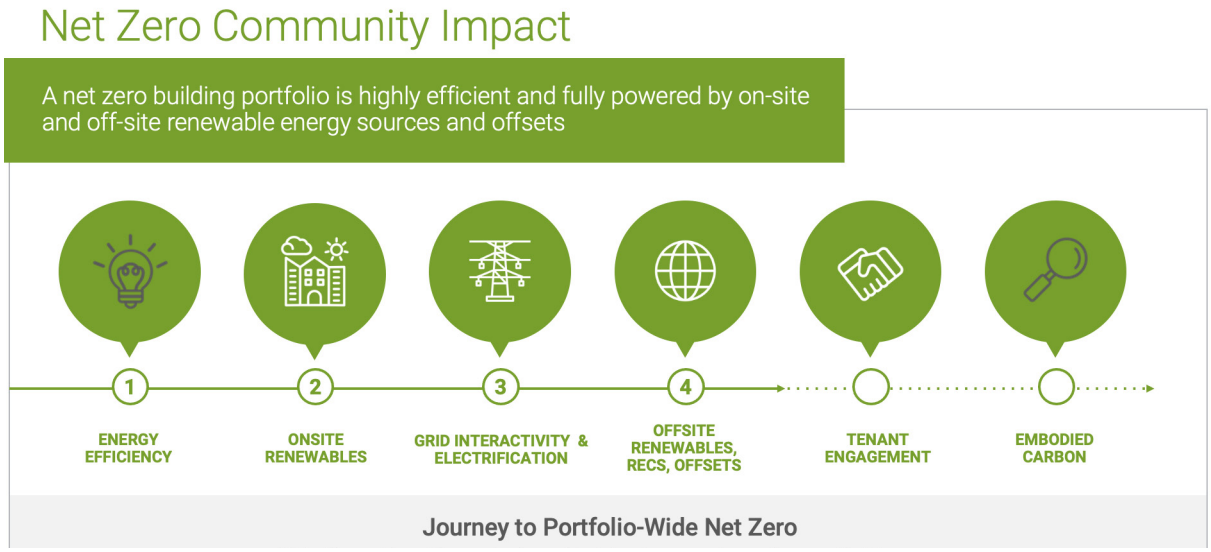
INTRODUCTION

In July 2021, ULI launched the global Net Zero Imperative to help accelerate market transformation toward a net zero built environment, defined as a building portfolio that is highly efficient and fully powered by on-site and off-site renewable energy sources. ULI's Net Zero Imperative (NZI), funded with generous support from ULI member Owen Thomas, supports the work of local communities seeking concrete ideas and strategies for real estate owners, public sector leaders, and the public to eliminate carbon emissions from the built environment and reach a state of zero net carbon emissions.

Why is this work important?

Over the past five years, nearly every country and more than 300 U.S. cities made a commitment to achieve the Paris Climate targets. As of 2020, only a handful of cities have made meaningful progress in developing climate action plans that will accelerate decarbonization of the built environment. Yet cities, countries, investors and tenants are still looking to the buildings sector to meet comparable greenhouse gas reduction goals.

Leading investors are including environmental, social, and governance (ESG) goals in their real estate debt and equity considerations, leading tenants are including it in their leasing decisions and regulators are incorporating a path to net zero into building codes and regulations for new and existing buildings.



NZI Goals

Using ULI's trusted Technical Assistance Panel (TAP) program, eight cities across the globe are working to achieve the following NZI goals for their community:

- Accelerate the decarbonization of the built environment,
- Chart a cost-effective path to net zero for the real estate industry,
- Leverage the power of ULI's global network to drive development and investment that supports this path to decarbonization,
- Get the private sector working together with cities on policy and incentives that can help accelerate investment in decarbonization and
- Develop case studies and tools based on global best practices highlighting cost-effective strategies across geographies, asset classes, and building types.

ULI's Role in Driving Toward Net Zero

As a global organization focused on transformative impact in communities worldwide, ULI has an important role to play in action toward a net zero built environment.

Deep Network

ULI has a deep network in cities across the globe and can bring leading experts on net zero together with the architects, builders, owners, investors, and policymakers who can make meaningful progress on decarbonization.

Private Sector Leadership

ULI is a steadfast leader in these cities throughout changes in government leadership or sentiment on climate. ULI is building capacity, interest, and investment in the private sector, building momentum towards decarbonization that will be sustainable. Additionally, through ULI's local district council network, it can provide connections, convening power, and local awareness in ways other organizations cannot.

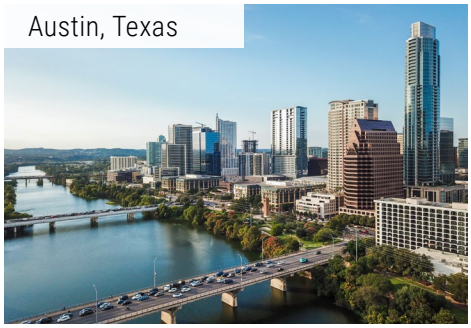
Cohort Engagement

As a global organization, ULI builds cohorts that help local leaders get the resources they need to succeed in their decarbonization efforts. ULI's goal is to connect local leaders with technical experts to work through the mechanics of decarbonization and connect local leaders with a global network of architects, developers, investors, and land use planners who can help move the industry forward on their goals.

Los Angeles was selected as one of eight global cities to advance the energy performance of buildings through the Net Zero Imperative. The other cities include Austin, Texas; Kansas City, Missouri; Minneapolis, Minnesota; San Jose, California; Shenzhen, China; Beijing, China; and Toronto, Canada. The multi-year cohort model will allow these cities the opportunity to collaborate and share best practices and collective resources.

Buildings are responsible for 40% of global greenhouse gas emissions and up to 70% of emissions in urban cities.

Austin, Texas

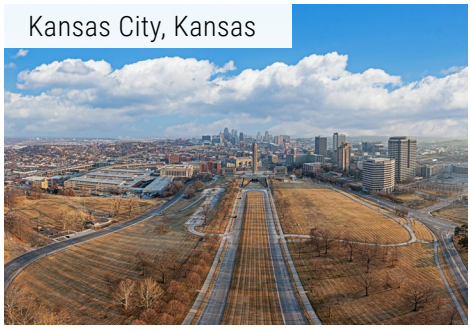


Minneapolis, Minnesota

Beijing, China

San Jose, California

Kansas City, Kansas



Shenzhen, China

Los Angeles, California

Toronto, Canada

Thanks to a generous gift from Owen Thomas, ULI has launched the Net Zero Imperative – a multi-year initiative to accelerate decarbonization in the built environment. Additional gifts from Lynn Thurber, Joe Azrack, Franz Colloredo-Mansfeld, and Dan Cashdan further support and bolster the NZI program's scale and impact. The program will hold technical assistance panels in eight global cities this year, designed to help building owners, cities, and other relevant constituents reduce carbon emissions associated with buildings, communities, and cities.

Los Angeles Technical Assistance Panel

Los Angeles NZI Study Scope

Local champions of this study, ULI-LA, LABBC, IBI Group, Arup and CenTrio sought to identify technical and market strategies to decarbonize the Bunker Hill neighborhood of Downtown Los Angeles by enhancing and expanding a district energy system across a range of asset types with multiple private owners. While the geographic scope of this study area was specific to the high-density commercial core of Downtown Los Angeles, the resulting recommendations are intended to serve as a scalable and replicable roadmap for cross-sector collaboration to harness the power of energy efficiency and grid integration at a community scale.

TAP Process & Experts

The technical assistance panel (TAP) process, objective and instructive by design, equipped the panelists with briefing materials prior to the TAP work sessions, tours of related geographies and sites, and interviews with key stakeholders to help further inform the panel around the issues for this market. Given the desire for a thorough study of the opportunities presented by the study area, this TAP lasted two days.

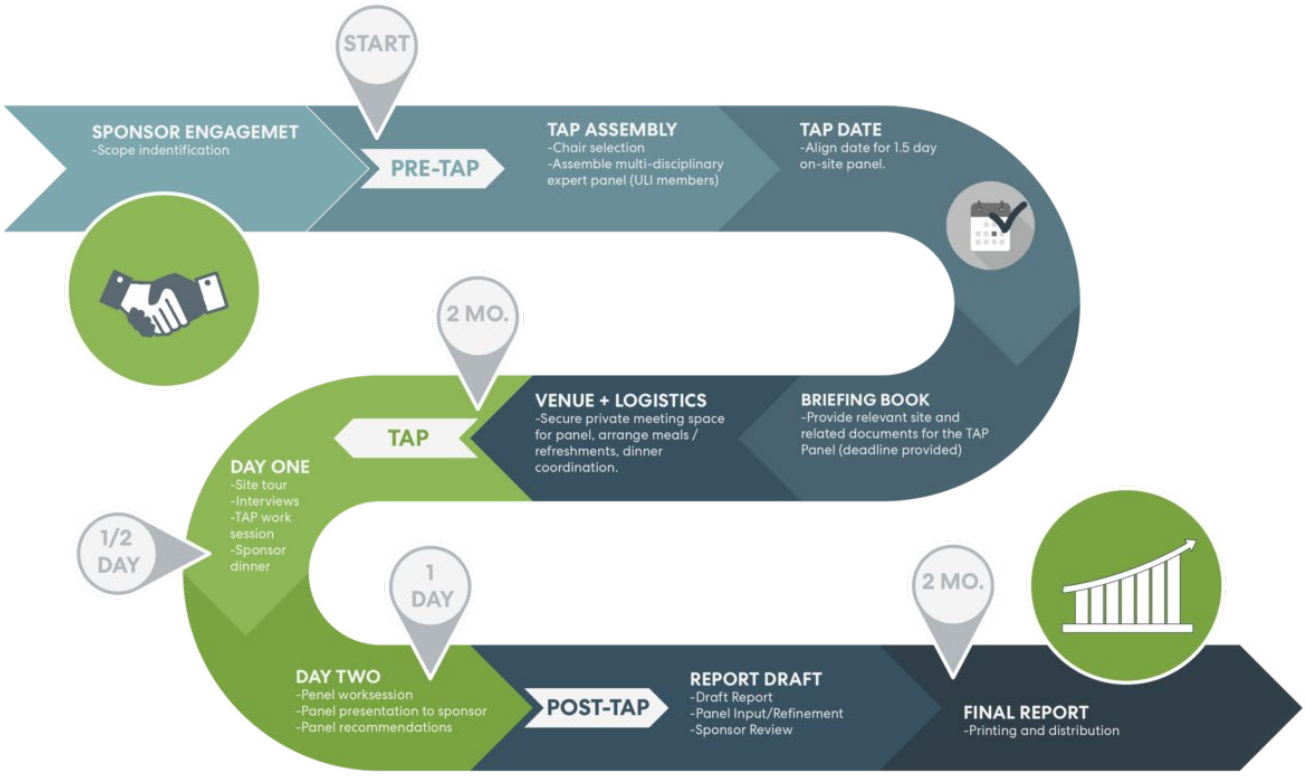
On the first day, with expert guidance from central plant owner-operator CenTrio and local energy efficiency advocacy organization LABBC, the panel toured the existing central plant in Bunker Hill, as well as key potential expansion corridors within the study area, identifying areas of opportunity and gaining a better understanding of the potential challenges.

On the second day, panelists worked through an intensive analysis of the specified issues before presenting their findings in a virtual public forum attended by members of the community and ULI local and national leadership.

Subject matter experts comprising the TAP panel provided the study with expertise in the areas of commercial real estate ownership and operation, development, finance, energy infrastructure, engineering, and public and environmental policy. All panel members volunteered to participate in the panel process and did not receive compensation for their work.

Stakeholder interviews held both in person and virtually via zoom introduced the panel to more than a dozen architects, engineers, lawyers, plant owners and operators, property owners and managers, utility representatives, and leaders of community organizations. The insights gathered from these interviews further informed the panelists' understanding of the Bunker Hill district energy opportunity and helped the panel begin to identify areas of collaboration, opportunity and need.

Panelists engage in a group work session.



Left: Panelists tour the CenTrio central plant facility on Bunker Hill; Right: Panelists engage in a group work session.

Bunker Hill thoroughfare Grand Avenue was so named in 1887 when City Council renamed it from "Charity Street," then home to Victorian-style mansions and hotels.

BACKGROUND & CONTEXT

A Global Climate Crisis

The world's foremost scientists agree that we are running out of time to avoid the worst impacts of the climate crisis. With global average temperatures already 1.1°C above pre-industrial levels, millions of people are already feeling the effects of climate change in their daily lives.

The Paris Climate Agreement, adopted in December 2015, was the world's first collective response to limit temperature increases to 1.5 or 2°C above pre-industrial levels, a point beyond which life on earth will become unrecognizable. Los Angeles adopted a motion in 2018 to support the Paris Agreement.

The Role of Buildings

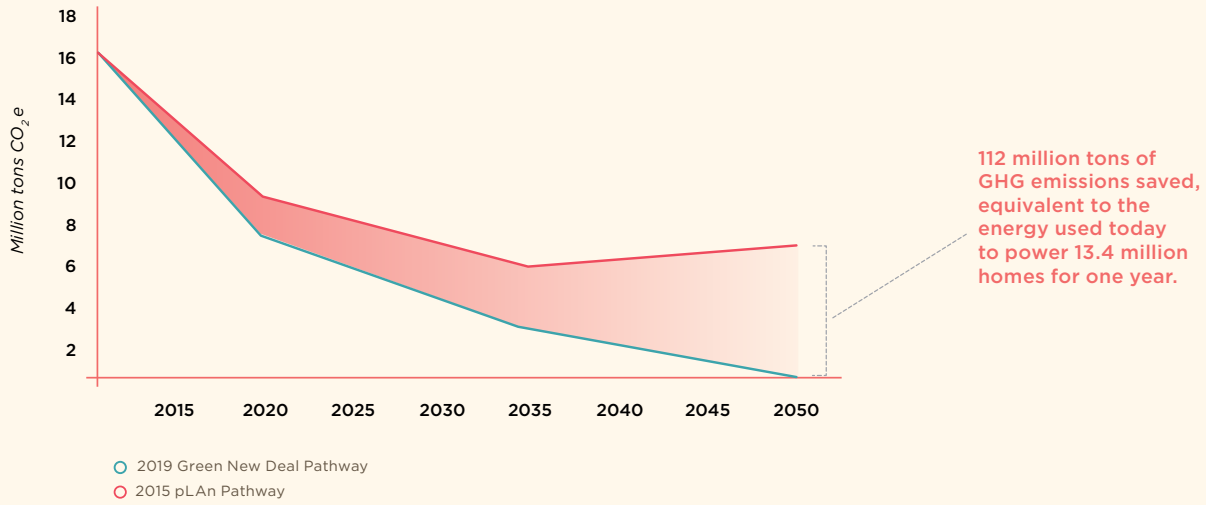
To futureproof our existing building stock, we must accelerate retrofit activity to a rate of 2.5% every year by 2030—up from less than 1% per year in 2021, according to a report by the International Energy Agency, titled "Net Zero by 2050."1

> "Any delay in reaching 2.5% of annual retrofits by 2030 would require such a steep subsequent ramp up as to make retrofitting the vast majority of buildings by 2050 virtually impossible. Modelling indicates that a delay of 10 years in the acceleration of retrofitting would increase space heating energy demand by 25% and space cooling demand by more than 20%, translating to a 20% increase in electricity demand in 2050."

1 *"Net Zero by 2050: A Roadmap for the Global Energy Sector,"* International Energy Agency, 2020

Emissions from Building Energy Use

L.A.'s Green New Deal Pathway calls for the steepest near-term reductions in GHG emissions from building energy use than any other sector and cuts 50% of emissions by 2025 and 100% by 2050.



Source: L.A.'s Green New Deal, 2019, p. 55

Building Performance Standards

The most powerful policy tool that a city has to accelerate retrofit activity is a building performance standard (BPS), which requires direct action by building owners to meet city-mandated performance improvement targets for their properties. These targets become stricter over time, driving continuous long-term improvement in the building stock.

In 2019, the District of Columbia and New York City each passed BPS policies requiring broad swaths of existing buildings to reduce greenhouse gas emissions or pay a penalty. Based on a report it commissioned, Washington D.C. estimates that its Building Energy Performance Standard will reduce energy use in buildings by more than 20%, thereby reducing carbon dioxide emissions by more than one million tons annually. Likewise, New York City projects that its standard, the Carbon Mobilization Act, will cut six million tons of carbon dioxide annually by 2030, prevent 43 premature deaths and 107 emergency room visits every year, and create at least 26,700 green jobs.[2] Since then, several other jurisdictions have followed suit, and Los Angeles is not far behind.

2 *"The ABC's of BPS: What You Should Know About Building Performance Standards," Institute for Market Transformation,* October 30, 2019

Climate Action in Los Angeles

LA's Green New Deal

Based on the city's commitment to the Paris Agreement, L.A.'s Green New Deal was released in 2019[3] to chart a revised course for Los Angeles' emissions reduction targets. It calls for cutting greenhouse gas emissions 50% below 1990 levels by 2025, 73% below 1990 levels by 2035 and becoming carbon neutral by 2050.

The Green New Deal is an expanded vision of the city's inaugural Sustainable City pLAn, which was first released in 2015. The updated plan calls for "securing clean air and water and a stable climate, improving community resilience, expanding access to healthy food and open space, and promoting justice for all—and for the future we have to build on behalf of our children and grandchildren."

Key Principles

- Commitment to urgent action with a scientifically driven strategy for achieving a zero-carbon grid, zero carbon transportation, zero carbon buildings, zero waste and zero wasted water,
- Responsibility to deliver environmental justice and equity through an inclusive economy, producing results at the community level, guided by communities themselves,
- Duty to ensure that every Angeleno has the opportunity to join the green economy, creating pipelines to good paying, green jobs and a just transition in a changing work environment and
- Resolve to demonstrate the art of the possible and lead the way, walking the walk and using the city's resources—our people and our budget—to drive change.

3 LA's Green New Deal, 2019

Clean & Healthy Buildings

Los Angeles is the #1 ENERGY STAR city in the country, but buildings are still the city's largest source of climate pollution. Buildings must be designed, built and rebuilt using passive energy principles, advanced efficiency measures and onsite renewable energy, while audits and retrofits will create local job opportunities and speed up technology innovation. But demand-side measures can only get us so far. To reach carbon neutrality by 2050, all Los Angeles buildings must operate 100% on clean power.[4]

Targets

- All new buildings will be net zero carbon by 2030; and 100% of buildings will be net zero carbon by 2050
- Reduce building energy use per square foot for all existing building types 22% by 2025; 34% by 2035 and 44% by 2050
- Recycle 100% of all wastewater for beneficial reuse by 20355
- Reduce potable water use per capital by 22.5% by 2025; and 25% by 2035; and maintain or reduce 2035 per capita water use through 2050

Los Angeles' Existing Buildings Energy & Water Efficiency Ordinance

In 2016, the L.A. City Council established the Existing Buildings Energy & Water Efficiency (EBEWE) Ordinance to reduce energy and water consumption in buildings within the City of Los Angeles. EBEWE requires owners of buildings larger than 20,000 square feet to comply with two basic requirements:

1. Benchmark and report energy and water consumption through ENERGY STAR Portfolio Manager (ESPM) annually
2. Achieve certain performance targets or perform audits and retro-commissioning on a five-year cycle

Benchmarking in ESPM assesses the energy performance of a building on a scale of 1 to 100, relative to similar buildings in the area. A rating of 50 indicates that the building performs better than 50% of similar buildings in the area. A rating of 75 can earn a building ENERGY STAR certification, which indicates superior performance. Audits and retro-commissioning identify specific systems within a building that can be retrofitted to reduce energy and maintenance costs and drives near-term savings through operational improvements.

4 LA Sustainable City pLAn 2019, Clean & Healthy Buildings, page 54

5 LA Sustainable City pLAn 2019, Local Water, page 44

Los Angeles' Building Performance Standard

Building on the EBEWE ordinance, the City of Los Angeles has begun taking steps toward developing a building performance standard (BPS). In December 2021, Councilmember Paul Koretz introduced a motion to begin a 120-day community engagement process led by the city's Climate Emergency Mobilization Office (CEMO). By February 2022, the City Council introduced a motion to require all new residential and commercial buildings in Los Angeles to be built to achieve zero carbon emissions by 2030. The motion instructed the Department of Building and Safety (LADBS), with assistance from the City Attorney, CEMO and all relevant departments to report back within 180 days with a plan for the implementation of an ordinance or regulatory framework effective on or before January 1, 2023.[6] By summer 2022, the Los Angeles Housing Department, LADBS and CEMO had begun stakeholder engagement for existing buildings.

LA100 Study

Critical to buildings achieving net zero on the necessary timeline is a "clean" power supply. In pursuit of an "equitable and abundant economy" powered by 100% renewable energy, the Los Angeles City Council passed a series of motions in 2016 and 2017 directing the Los Angeles Department of Water and Power (LADWP) to determine technical feasibility and investment pathways. Partnering with the National Renewable Energy Laboratory (NREL), a U.S. Department of Energy (DOE) research lab with decades of experience in energy systems analysis, LADWP released its groundbreaking Los Angeles 100% Renewable Energy Study (LA100) in March 2021, which found that Los Angeles could achieve reliable 100% renewable power as early as 2035. LADWP recently announced it would provide a grant to UCLA to develop strategies to put the LA100 study into action, with a specific focus on social equity goals laid out in the report.

6 Councilmember Nithya Raman Introduces Motion to Require All New Buildings Constructed in Los Angeles Be Zero Carbon

Downtown Los Angeles Overview

Demographics

The Downtown Center Business Improvement District (DCBID), an area that includes Bunker Hill and the adjacent Financial District, along with South Park, the Civic Center and the Historic Core, is home to almost 80,000 residents. The working population dwarfs this figure, ballooning the weekday population to over 500,000.

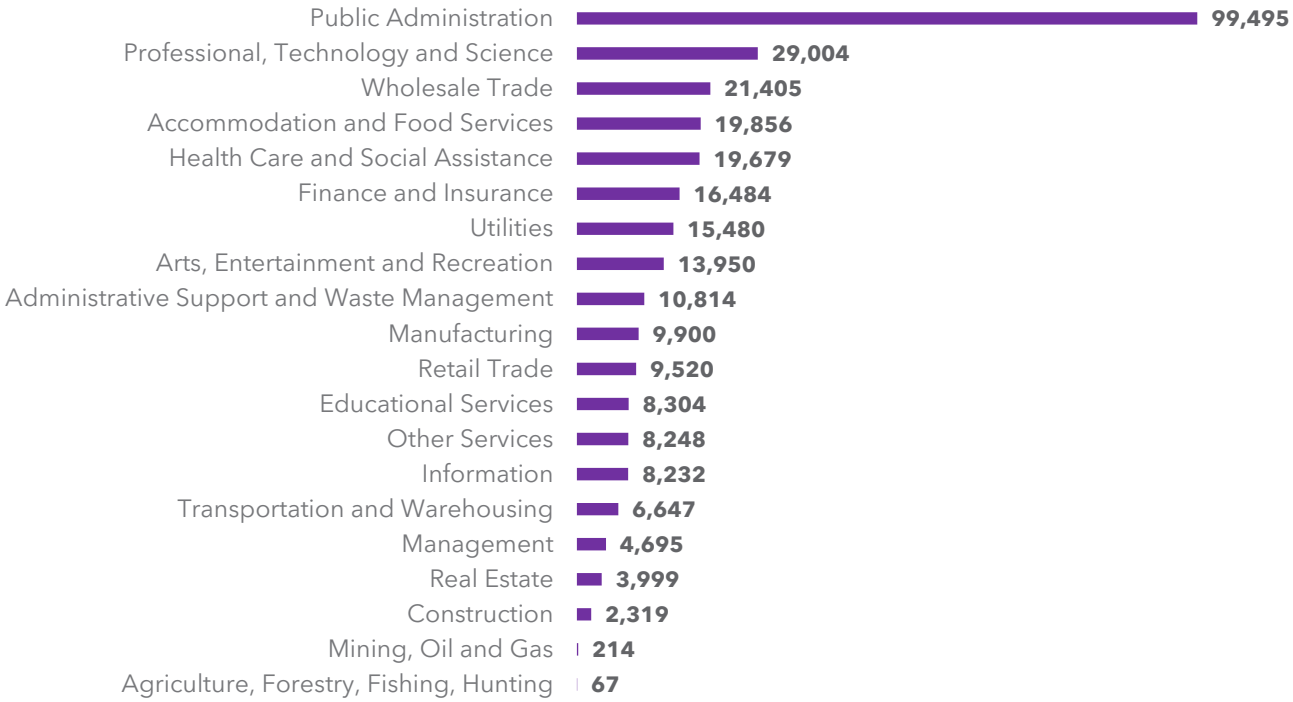
Residents are slightly better off than the city average, with median incomes of $33,000. They are also highly educated—60% have a postsecondary education.[7] Residents are predominantly young working-age professionals with smaller than average household sizes (1.7, compared to 2.8 citywide).[8] The region is also diverse, with 32% of residents identifying as Hispanic or Latino 26% Asian or Pacific Islander, and 16% African or African American. Key employment sectors include Arts and Entertainment (15%), Business or Professional Services (15%), and Government Services (14%).[9]

7 *"DTLA Outlooks and Insights,"* Downtown Center Business Improvement District, 2022

8 *"DTLA Insights,"* Central City Association, 2019

9 *"DTLA 2020 Survey,"* Downtown Center Business Improvement District, 2020

Number of Jobs in DTLA by Industry



LODES Version 7.3; "DTLA Insights," Central City Association, 2019

Public Land

Downtown Los Angeles hosts the largest concentration of government employees in the United States outside of Washington, D.C. Nearly 100,000 people were employed there in public administration as of 2019, many of them in the Civic Center, an area immediately adjacent to Bunker Hill that is roughly bounded by the U.S. 101 freeway (north), the LA River (east), First Street (south) and the CA 110 freeway (west). As such, Downtown Los Angeles has an abundance of publicly owned property, a good portion of which is occupied by existing buildings but much of which is slated for development—or redevelopment—with a focus on the need to provide affordable multifamily housing.

Concentrated most heavily in the Civic Center, public property downtown is owned by all levels of government—city, county, state and federal—for a variety of purposes, including offices, courts, municipal services such as transportation, fire and police, as well as public open space

Residential Development

Downtown Los Angeles has outpaced the broader market in new residential construction, with $14 billion invested in residential construction and $8 billion in mixed-use development since 1999.[10] Since the Adaptive Reuse Ordinance (1999), which incentivized residential and hotel conversion of historic, under-utilized commercial buildings, Downtown Los Angeles added approximately 30,000 residential units (close to 42,000 today, up from roughly 12,000 in 1999), growing from a population of 18,000 to near 80,000. Most of these residents are renters (90%), compared to 63% citywide. Indeed, between 1999 and 2019, 30% of L.A.'s new apartments were built downtown. The Central City Association of Los Angeles (CCA) projects 130,000 total units by 2040.

Downtown is also the epicenter of the homelessness crisis in Los Angeles. Skid Row, a 50-block area bordering the Historic Core and the Arts District, is home to the largest homeless population in the country. At last count in January 2021, nearly 2,000 people sought temporary shelter there, and many more spent the night unsheltered.[11] Pollution and extreme heat compound the challenges, even for those in the area fortunate enough to be permanently housed. Many low-income residents do not have access to air conditioning, or if they do, cannot afford to run it, making access to cooling an urgent social equity and public health issue. Recognizing the seriousness of the public health risk, the L.A. City Council appointed its first Chief Heat Officer in June 2022.

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10 "Downtown LA Market Report, Third Quarter, 2021," Downtown Center Business Improvement District, 2021

11 HIC and Shelter Count Skid Row, LAHSA, 2021

Metro Development Policy

In June 2021, Metro adopted its most recent joint development policy, under which all new joint development sites with housing components will be required to ensure 100 percent of residential units serve income-restricted persons and families of extremely low, very low, lower or moderate income, in alignment with neighborhood incomes.[12]

When practicable, similar targets will be pursued on previously acquired sites. When projects comprised of 100 percent affordable housing are deemed infeasible, the policy would then prioritize a mix of affordable and market rate housing and look within the affordable housing component for a mix of affordability levels as follows:

- Extremely Low Income: 11% of units
- Very Low Income: 15% of units
- Lower Income: 25% of units
- Moderate Income: 50% of units

Los Angeles County Plant

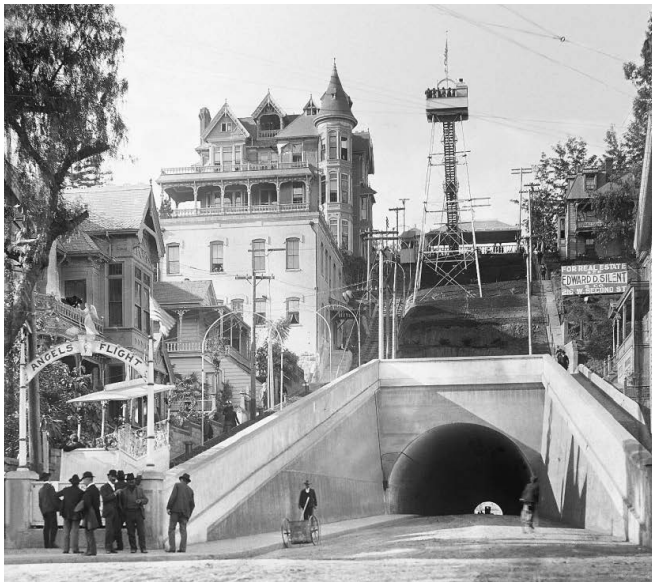
A second district cooling plant in Downtown Los Angeles is owned and operated by the county. Located only a few blocks from the Bunker Hill plant on Temple Street between North Broadway and Hill streets, the county plant serves roughly a dozen buildings in the Civic Center area. The plant was described as "the first of its kind" when built in the late 1950s:

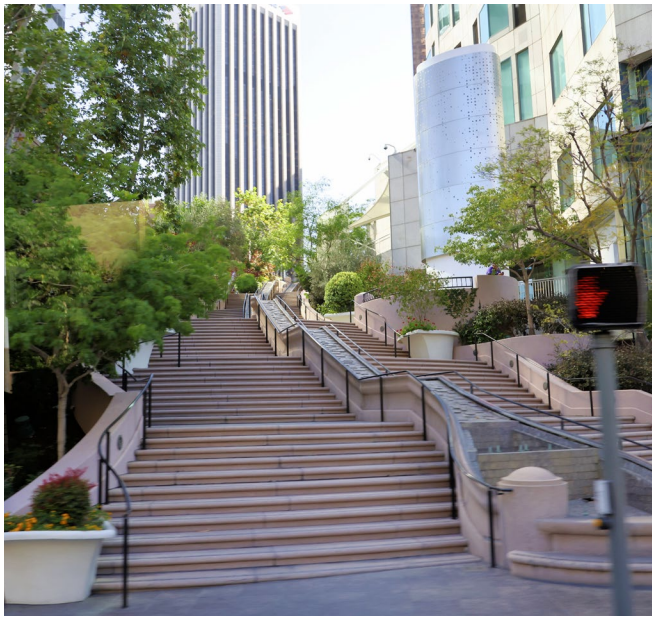
"The first of its kind in the nation, this complex octopus-like system will carry heat and refrigeration to various county buildings […] It will be completely automatic and will supply the heating and air conditioning for all the county-owned buildings, both present and future, in the new Civic Center."

The plant has gone through various expansion and upgrades over the years and is purported to be due for an overhaul in the near term.

Los Angeles County Plant

12 Joint Development Program, Metro





Top: Angels Flight at the corner of 3rd and Hill streets in downtown Los Angeles on opening day, Dec. 31, 1901. (Los Angeles Times) Bottom: Bunker Hill Steps

Why Bunker Hill?

Bunker Hill is a thriving commercial district in the northwest corner of Downtown Los Angeles that has undergone significant change over the last 150 years. Comprising roughly 30 blocks, the neighborhood is bounded by Route 110, or the Harbor Freeway, to the west, South Hill Street to the east, West 6th Street to the south, and West 1st Street to the north.

In the late 19th century, the area was an affluent residential neighborhood, home to grand Victorian mansions and Beaux Arts apartment buildings that housed Los Angeles' moneyed elite.[13] In the early 20th century, as neighborhoods further from downtown became more desirable, these wealthy residents moved away to be replaced by working-class renters, often new immigrants. By the 1920s, Bunker Hill was a diverse, low-income neighborhood, with residents from Indigenous groups, Mexico, Europe and the Midwest. Around this time, one in five residents were foreign-born. Freeway expansion and increasing suburban development in the 1940s and 1950s led to depopulation and displacement of employment opportunities, undercutting services and support for communities in Bunker Hill.

13 *"Timeline: How Bunker Hill transformed Los Angeles and Grand Avenue,"* Los Angeles Times, May 22 2019

These trends led to the perception of Bunker Hill as a "blight" on Downtown L.A., in need of sweeping removal and rehabilitation. The 1949 Federal Housing Act, which made possible broader applications of eminent domain, set the stage for mass evictions, clearances and urban renewal policy. In 1959, the City Council passed the Bunker Hill Renewal Project, which erased residential neighborhoods over the following decade. Land was turned over to private developers, beginning a process of reconstruction on Bunker Hill, still ongoing, as a local, regional and global hub for commerce, entertainment, arts and culture.

Today, the area is a cultural and commercial hub, home to large corporate offices, hotels, entertainment venues, museums and art galleries. Significant destinations and key institutions invested in the area's growth and success include the Museum of Contemporary Art (MOCA), the Broad, the Music Center, the Walt Disney Concert Hall, the Colburn School, and REDCAT. Bunker Hill's position as a global destination for innovation, arts and culture has led to significant growth in new residential and mixed-use development, bringing thousands of new long-term residents to the area.

All this development sits atop a hidden opportunity to catalyze yet another transformation: a district energy plant with potential to unlock significant decarbonization opportunities throughout downtown Los Angeles. Developed on Bunker Hill in the late 1960s near the beginning of what became the heyday of commercial development in that area, the Bunker Hill plant is owned and operated by CenTrio Energy (formerly Enwave USA), the leading "pure-play district energy platform in the U.S."[14] Having purchased the Bunker Hill system in 2017, the energy company also owns and operates assets in Chicago, New Orleans, Houston, Syracuse, Denver, Los Angeles, Seattle and Portland, operating intelligent thermal energy systems that generate, store and share energy.

Bunker Hill Plant

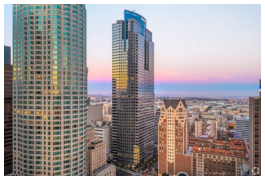
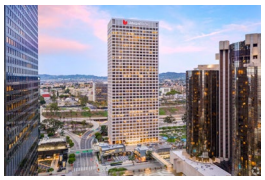
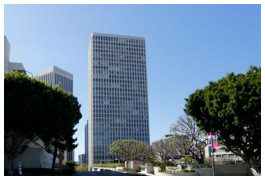
The Bunker Hill system currently serves a dozen office towers, residential buildings and hotels, providing between 8,400 and 9,700 tons of chilled-water cooling from a system with an existing capacity of 12,500 tons and potential to expand to 20,000 tons. The chilled water plant benefits from independent electricity feeds from two different LADWP substations and high-priority return-to-service status in case of power outage (second only to hospitals). As the owner and operator of the existing system, CenTrio maintains and upgrades district infrastructure, while managing connection to existing buildings and new developments.

Existing central plant infrastructure sits below City National Plaza at 515-555 S. Flower Street, a 52-story twin tower commercial office skyscraper complex owned by CommonWealth Partners. The plant provides chilled water to buildings in the immediate vicinity, having recently decommissioned a legacy hot water loop. Buildings currently connected to the system include:

Panelists tour the CenTrio central plant facility on Bunker Hill.

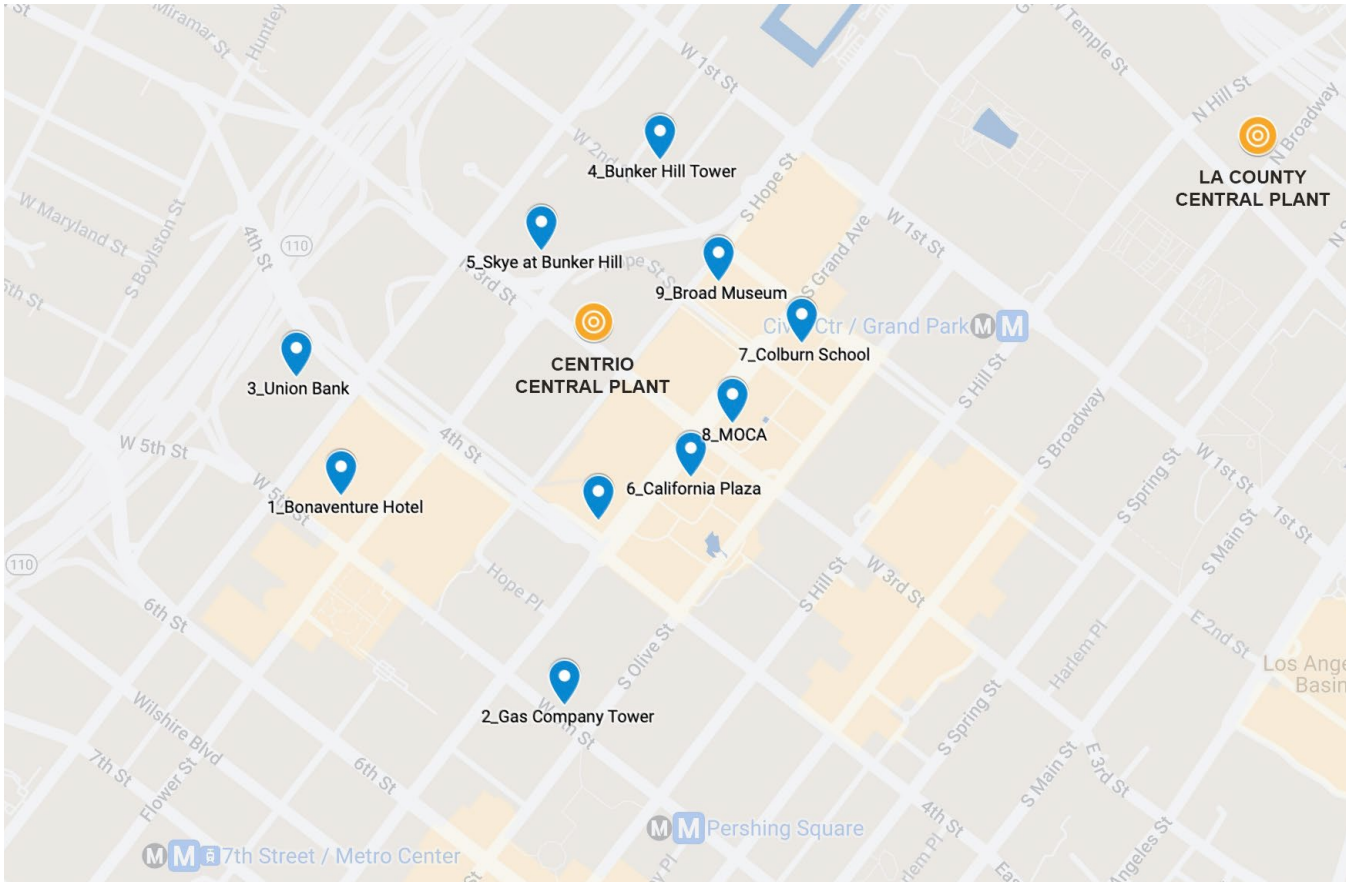
14 *"CenTrio: Discover the freedom to do more,"* CenTrio, 2022

Table 2.1 Buildings connected to Bunker Hill central plant infrastructure

MAP #	BUILDING PHOTOGRAPH	BUILDING & ADDRESS	USE TYPE	GROSS AREA (SF)	YEAR BUILT
1		**Bonaventure Hotel** 404 S Figueroa St	Hotel	650,000	1974
2		**Gas Company Tower** 555 W Fifth St	Office, Retail	1,430,000	1991
3		**Union Bank** 445 S Figueroa St	Office	900,000	1968
4		**Bunker Hill Tower** 800 W First St	Condominium	245,000	1968
5		**Skye at Bunker Hill** 234 S Figueroa St	Multifamily	446,000	1968
6		**California Plaza** 300 S Grand Ave	Office, Retail	2,440,000	1985, 1992
7		**Colburn School** 200 S Grand Ave	Education	276,000	1998
8		**MOCA** 250 S Grand Ave	Cultural	106,000	1986

MAP #	BUILDING PHOTOGRAPH	BUILDING & ADDRESS	USE TYPE	GROSS AREA (SF)	YEAR BUILT
9		**Broad Museum** 221 S Grand Ave	Cultural	120,000	2015
10*		**Wells Fargo Center South** Tower 355 S Grand Ave *(* Pending Connection)*	Office, Retail	3,433,000	1983

Map 2.2 Existing connections to Bunker Hill central plant infrastructure

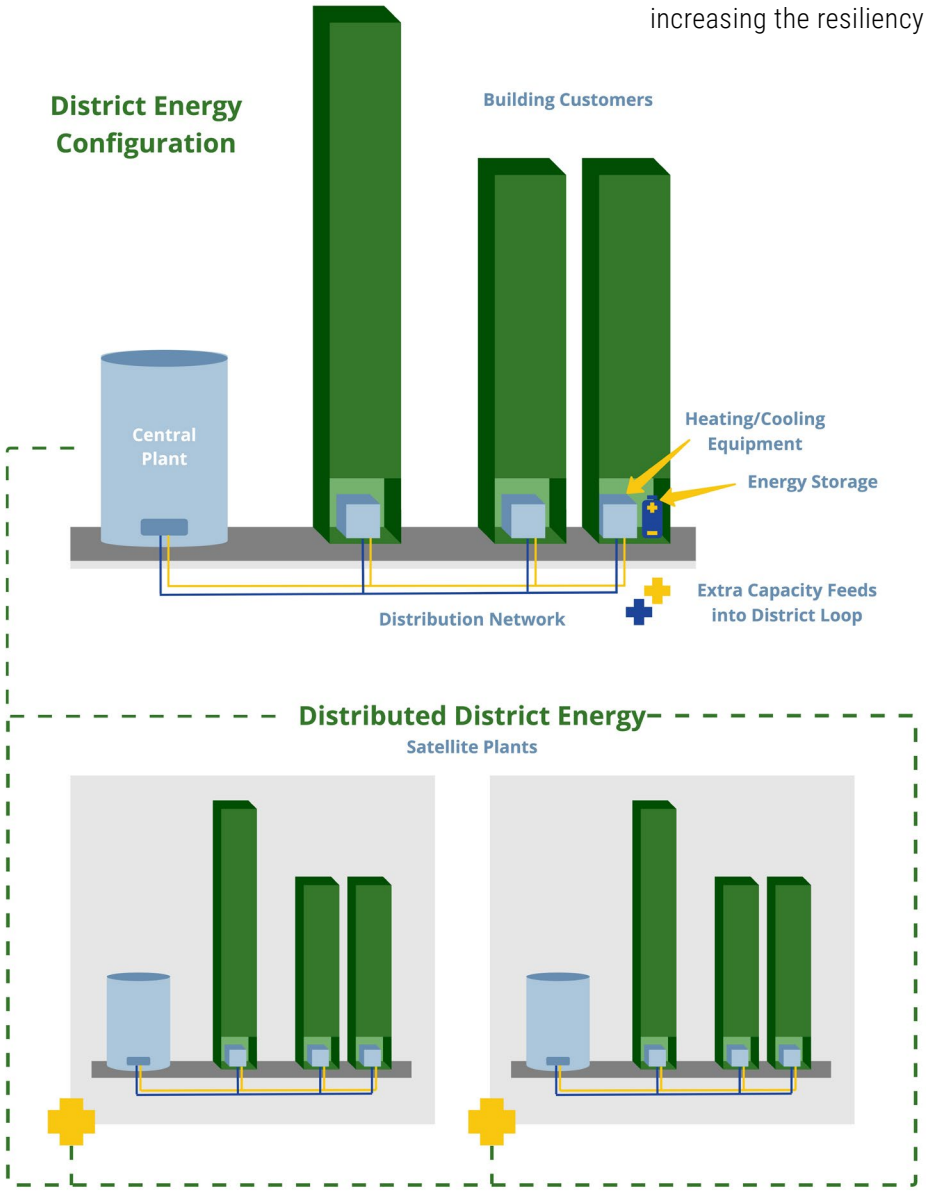


Distributed District Energy

District energy systems provide heating and/or cooling for multiple buildings within a given area, providing hot and/or cold water from a single central plant. These systems can also incorporate energy storage, combined heat and power systems or other distributed energy resources (DERs) to deliver energy more efficiently and can be powered by renewable energy to deliver additional environmental benefits.

"Distributed" district energy systems link together multiple district plants, or connect chiller plants located within connected buildings, to increase efficiency and resilience by further diversifying loads, increasing flexibility and taking advantage of increased economies of scale.

While establishing buy-in to manage HVAC energy across multiple varied assets can be challenging, doing so can optimize operation of existing assets, while also increasing the resiliency of the system.



Example of a district energy configuration

Bunker Hill Energy Assessment

In the weeks leading up to the panel's working session, global engineering firm Arup performed a preliminary energy assessment of expanding the existing Bunker Hill system to assess the various potential benefits. The study specifically evaluated the potential for energy and greenhouse gas savings associated with:

- Maximizing the number of buildings connected to the Bunker Hill plant for chilled water
- Electrification of connected buildings' heating systems
- Connecting distributed plants, as well as potential benefit provided by energy storage

The assessment looked at 18 buildings in and around Bunker Hill (three of which are currently in development), including the 11 buildings currently connected to CenTrio's Bunker Hill central plant. The additional buildings were selected based on their proximity to the current Bunker Hill plant and CenTrio's current plans for expansion of the chilled water loop.

Because the buildings included in the assessment span a wide array of characteristics and use types, including office, hotel and residential uses, the plant can take advantage of the varying times when these buildings require thermal energy, which drives energy efficiencies when combined across a thermal network.

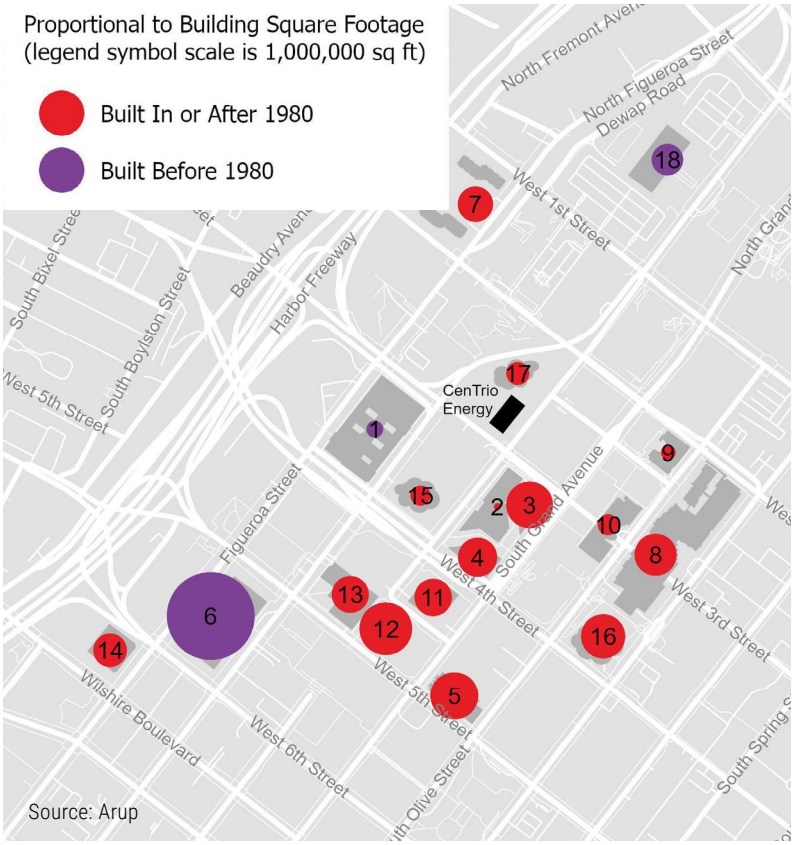


TABLE 2.2 Buildings included in the ARUP study

	Building	Year Built	Square Footage
1	World Trade Center Los Angeles	1975	395,955
2	Halo	1982	65,000
3	Wells Fargo North Tower	1982	1,391,000
4	Wells Fargo South Tower	1982	1,140,000
5	The Gas Company Tower	1991	1,431,880
6	City National Plaza	1971	2,758,100
7	Promenade Towers Apartments	1985	1,007,888
8	Angelus Plaza	1982	1,242,531
9	Expansion of Colburn	2007	325,000
10	Omni Los Angeles Hotel	1992	540,028
11	400 South Hope	1982	1,080,731
12	US Bank Tower	1989	1,586,742
13	FourFortyFour South Flower	1981	1,071,276
14	Figueroa at Wilshire	1990	950,000
15	New Bank of America Residential Tower*	2030	510,000
16	Angels Landing*	2030	1,300,000
17	Re/Met Bunker Hill Metro Grand Panorama*	2030	600,000
18	John Ferraro Building	1965	880,537

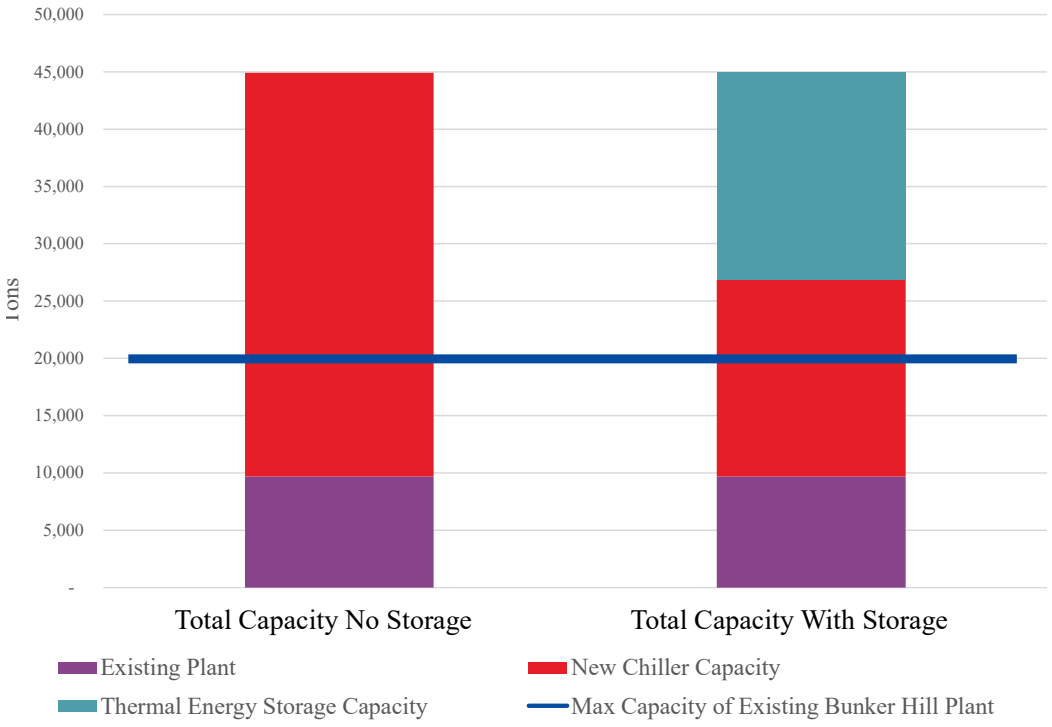
** INDICATES FUTURE DEVELOPMENT*

District energy increases energy efficiency, enhances resiliency, and offers a pathway to unlock decarbonization opportunities for buildings with aging infrastructure.

Building energy profiles were created using Department of Energy prototype profiles, scaled to estimated building capacity based on estimated load per square foot. Actual load data would increase the accuracy of the assessment and should be considered for future study. Arup combined individual building energy profiles to determine a district energy profile. Chiller efficiencies for each building were assumed and applied to this profile based on estimated vintage of equipment, while Bunker Hill plant efficiency data was provided by CenTrio.

18% Energy Savings in Making the Switch to District Cooling

TABLE 2.3 Central Plant Capacity



Source: Arup

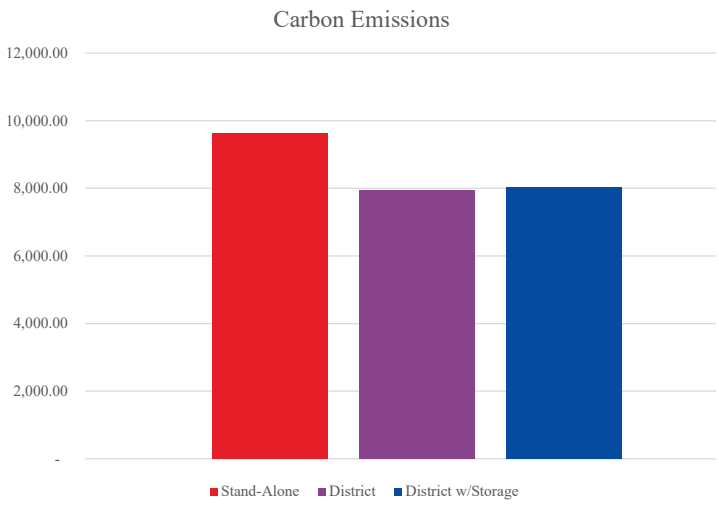
The current Bunker Hill plant has 9,700 tons connected with space to provide up to 20,000 tons (blue line). With the additional 18 buildings, an additional 25,000 tons of capacity will need to be found. This could be distributed in a 'distributed plant' among other locations. If a thermal energy storage tank is used, only 7,000 additional tons would need to be added to the current plant location or other 'distributed plant' locations.

Chilled Water Capacity

As the study progressed, it was determined that the Bunker Hill plant, as currently configured, does not have capacity to serve the 18 buildings considered in this assessment. However, the study is still illustrative of the high-level potential benefits and opportunities, and future study should focus on the subset of buildings in the areas whose combined loads falls within the plant's maximum capacity. To serve the 18 selected buildings and increase capacity, CenTrio may consider connecting existing chillers in nearby buildings—this is the idea behind the "distributed" concept for district energy. If the district energy system were able to provide sufficient chilled water for all 18 buildings, an overall reduction in likely carbon emissions would be due to the efficiencies of a large central plant operating in an optimized manner.

TABLE 2.4 Chilled Water Carbon Emissions

Electric CO2 emissions factor	513.46	lb/MWh



	Stand-Alone	District
Total Emissions (metric ton)	9,621.99	7,937.90

Source: Arup

The district chilled water approach has lower factor 513.46 lb/MWh carbon emissions due to the efficiency of the chillers. The chillers can be controlled to run at maximum efficiency across the plant as opposed to singular chillers at each building needing to ramp up and down.

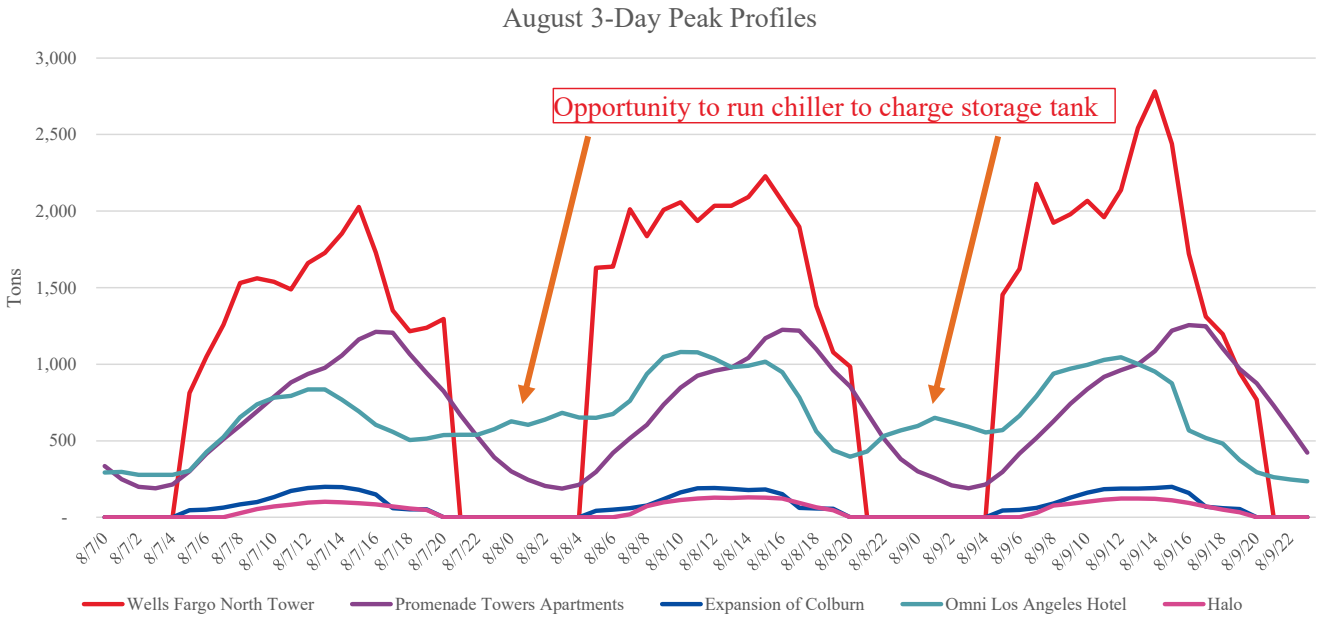
In this example, the district chillers save ~2,000 metric tons. This number should be refined more as the chillers and loads are defined.

The district option with storage does not make a significant difference for carbon emissions, as it will use similar energy, just at different times.

Optimal Operation Through Energy Storage

Arup's assessment found that the Bunker Hill chilled water system would benefit from using thermal (ice) energy storage to reduce demand on the electrical grid at peak times and benefit from lower-cost energy prices to produce the same volume of chilled water. The location of this storage system would need to be coordinated and could potentially take advantage of space in basements of nearby existing buildings, space within CenTrio's current Bunker Hill plant facilities, or other vacant space.

TABLE 2.5 Load Shifting With Storage



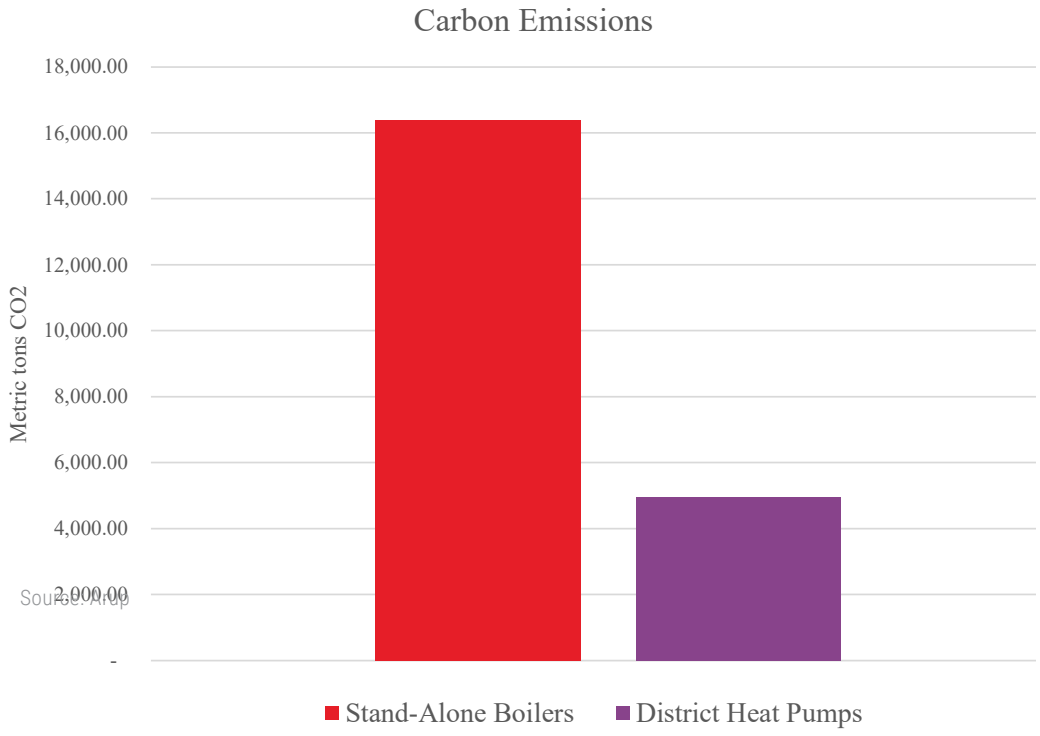
Source ARUP

This three-day profile in August on a peak day shows the opportunity to run the chiller for CHW storage at lower load (and lower cost electricity) times. The orange arrows show when the chillers could run to charge the chilled water storage tank so that they run less in during the day, but still meet the building peak needs.

Hot Water Potential

Converting both office and residential buildings from gas heat to electric is key to achieving a net zero carbon future. Though CenTrio does not currently have an operating piping system in place to distribute hot water, operating a district system that provides heat through a combination of low carbon technologies, such as electric heat pumps, heat recovery or sewer heat mining could significantly reduce the carbon emissions of customer buildings. Heat pumps are significantly more efficient than boilers, which most buildings still use. Moving from gas to electricity also offers the opportunity to connect to cleaner energy. Many downtown buildings may have difficulty decarbonizing their heating systems due to electricity service limits or lack of available space for new technologies, so a decarbonized distributed district heating system could be both effective and attractive if there were a critical mass of buildings interested.

TABLE 2.6 Heating Carbon Emissions



Because the baseline is less efficient gas boilers compared to over 3x efficient electric heat pumps, the heat pump options emit over 10,000 metric tons less carbon. As new buildings come online – they should consider using heat pumps instead of gas boilers, even if not connected to a district hot water plant. Centralized electric heating offers a significant opportunity to help space constrained existing buildings in DTLA decarbonize.

The Value Proposition

District Decarbonization

Office and other commercial buildings have historically used electricity for air conditioning, and natural gas for space heating and domestic hot water. As noted above, a switch from onsite generation of air conditioning to a district cooling system showed an 18% savings in energy use for the chilled water generation component of building environmental control.

At 1,684 metric tons per year, estimated carbon emissions savings gained from the efficiency of a district cooling system rather than stand-alone chiller plants would be roughly equivalent to the carbon emitted from 212 single-family homes. If the expanded district cooling plant were operating on renewable electricity, carbon savings would rise by an additional 7,937 metric tons per year, or the equivalent of more than 1,200 single-family homes. While these savings are not trivial, neither are they a substantial movement toward net zero carbon. The critical benefit, then, is that these savings are coupled with two additional benefits: that both physical space and electrical capacity may be freed, or "liberated," to support additional decarbonization efforts.

Chilled water electricity savings enable two co-benefits: physical space and electrical capacity can be "liberated" to unlock value and support additional decarbonization strategies.

TABLE 2.7 Estimated Savings in Energy Use & Greenhouse Gas Emissions

	Stand-alone Chiller Plants in Existing Buildings	District Cooling Efficiencies	District Cooling Efficiencies with Thermal Storage
Annual Chiller Electricity Usage (kWh)	41,301,871	34,073,018	34,444,246
Total Annual Emissions (metric tons)	9,621.99	7,937.90	8,024.38

The Benefits of Liberated Space

When a building with a standalone chiller and/or cooling tower plant connects to a district cooling energy provider, it no longer has need for in-house equipment, unless the equipment is being preserved for backup. Building ownership then has the option to decide what to do with the former chiller room and cooling tower yard.

In one scenario, a building owner might opt to keep chiller equipment onsite. If that is the case, the district energy provider (CenTrio, in this case) might wish to lease the space to upgrade and operate a supplemental cooling generation facility or create a thermal storage "node" on a larger distributed energy system.

In a second scenario, a building owner might prefer to decommission and remove its chiller equipment. In that case, the refrigerant machinery room that once accommodated a chiller could now be used to house a new heat pump heating system, for example, and a cooling tower yard could be repurposed as terraces or public amenity space. Depending on the former equipment's location within the building, space could be recaptured in a wide variety of ways for expanded program functionality.

Potential Beneficial Uses of Liberated Space in Existing Buildings:

- Liberated mechanical space in the basement can be used to accommodate new electrified heating equipment, energy storage technologies (batteries), thermal energy storage, relocated or expanded server rooms, or other technology spaces not requiring daylight.
- Roof space occupied by cooling towers could be repurposed for public space, expanded programing (for example, a rooftop restaurant or penthouse offices) or used for solar photovoltaic installation.

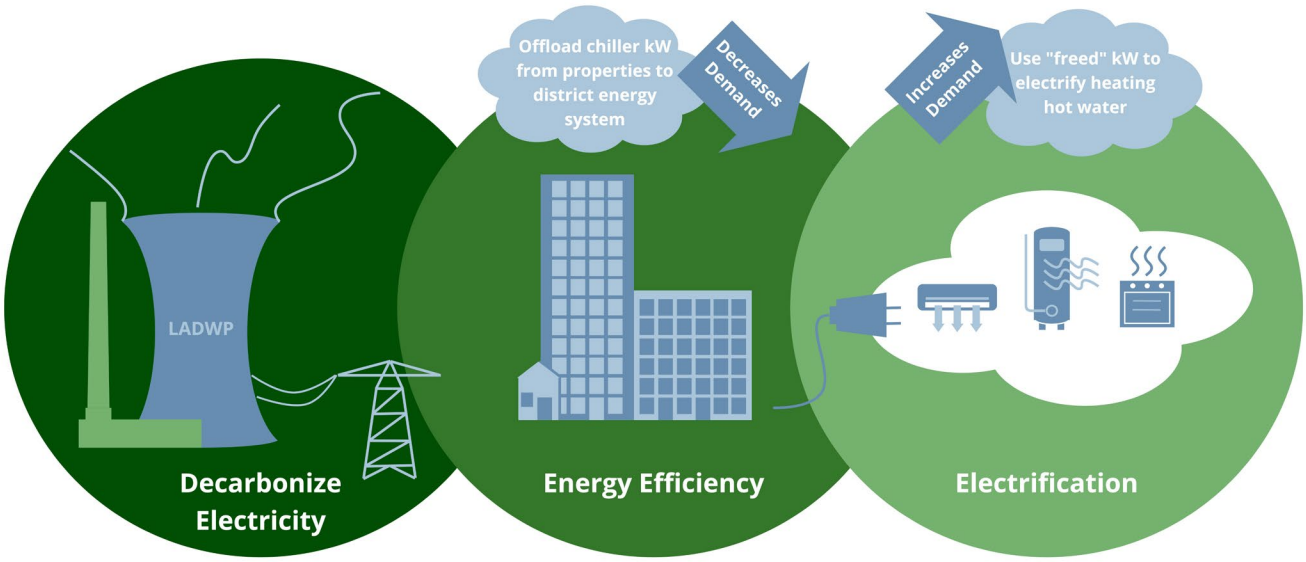


TABLE 2.8 Comparison of Installed Peak kW

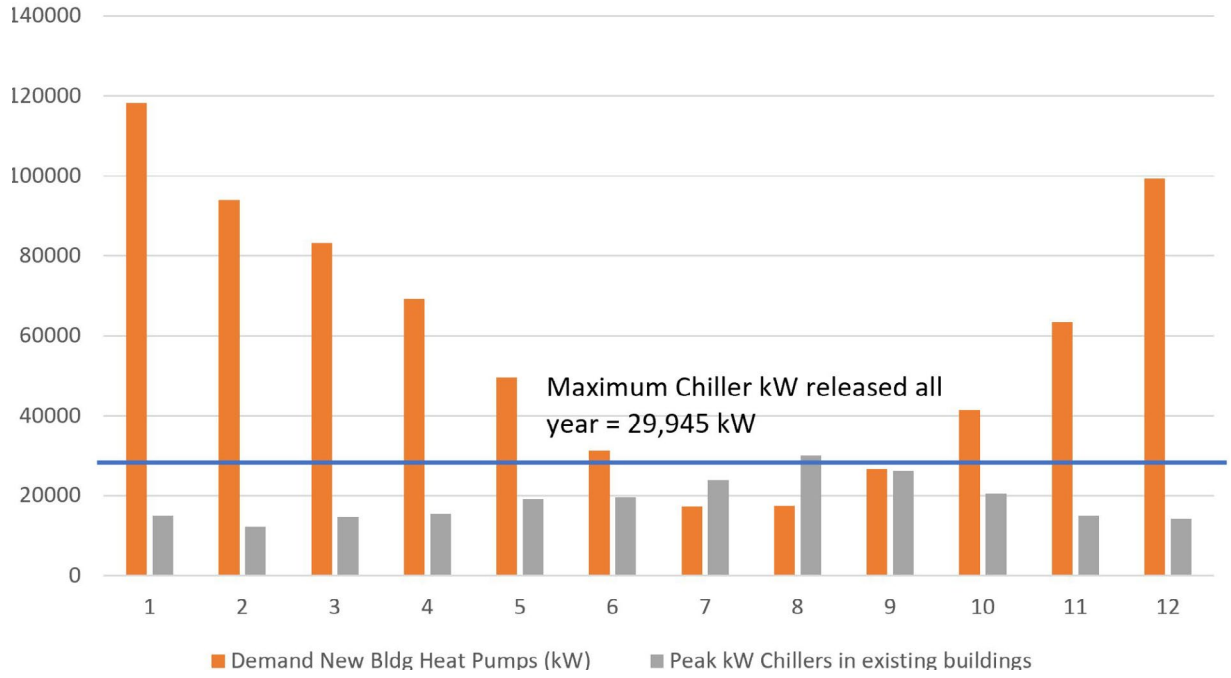
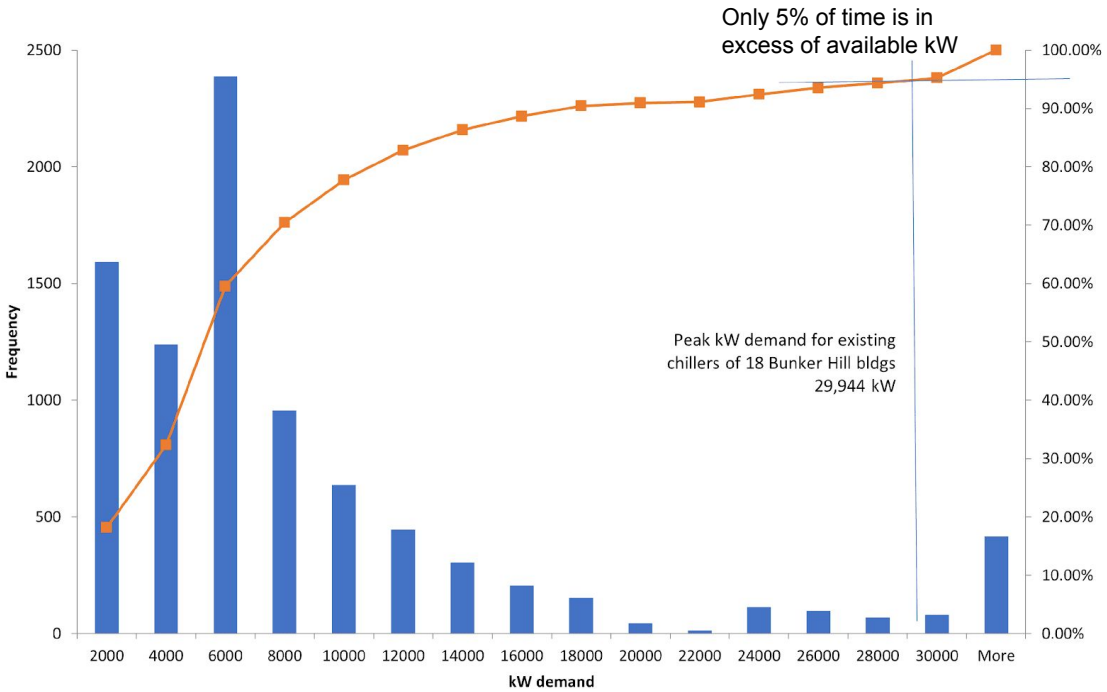


TABLE 2.9 Histogram Frequency of Hours for Peak kW Demand for Heating if Heat Pumps Are Used



For new buildings, avoiding the need to construct a building-level central plant offers other potential benefits.

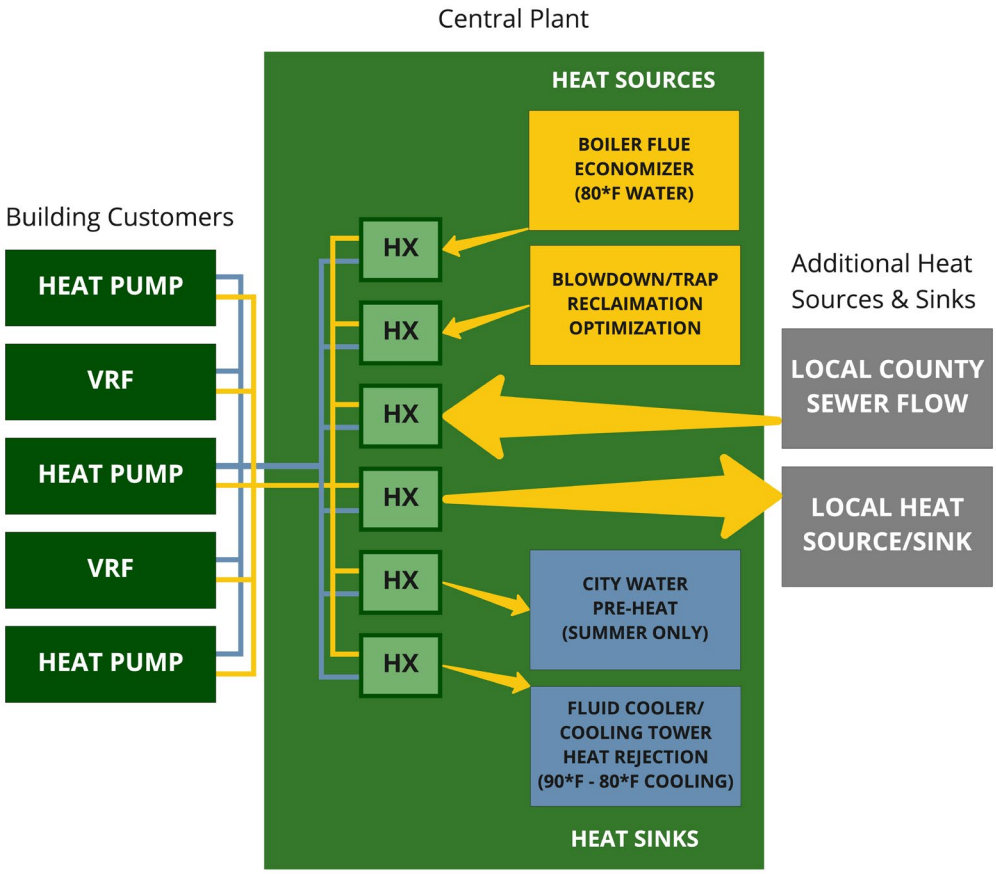
Potential Beneficial Uses of Liberated Space for New Buildings:

- Reduced construction and maintenance costs could enable lower rents or otherwise provide deeper affordability for tenants, especially in residential development.
- Reduced materials required for construction means reduced embodied carbon.
- Rooftop and interior space could be used for amenities.

The Benefits of Liberated Electrical Capacity

In addition to freeing up physical space, shifting chilled water generation to a district cooling energy system also provides a building with valuable freed electrical capacity. Electricity that once went toward cooling water to provide air conditioning may now be repurposed to support a shift away from fossil fuels toward electrification, without putting outsized demand from the building on the electrical grid. This might look like shifting heat generation from natural gas to all electric heat pumps or meeting increased demand for electric vehicle charging, for example.

One of the concerns with a mass electrification program such as that the City of Los Angeles has outlined in its Green New Deal is the unknown number of buildings that might require expensive upsized electrical service to meet new loads as the energy transition advances. When a building's total peak kilowatts, or electrical capacity, can be held constant through energy efficiency

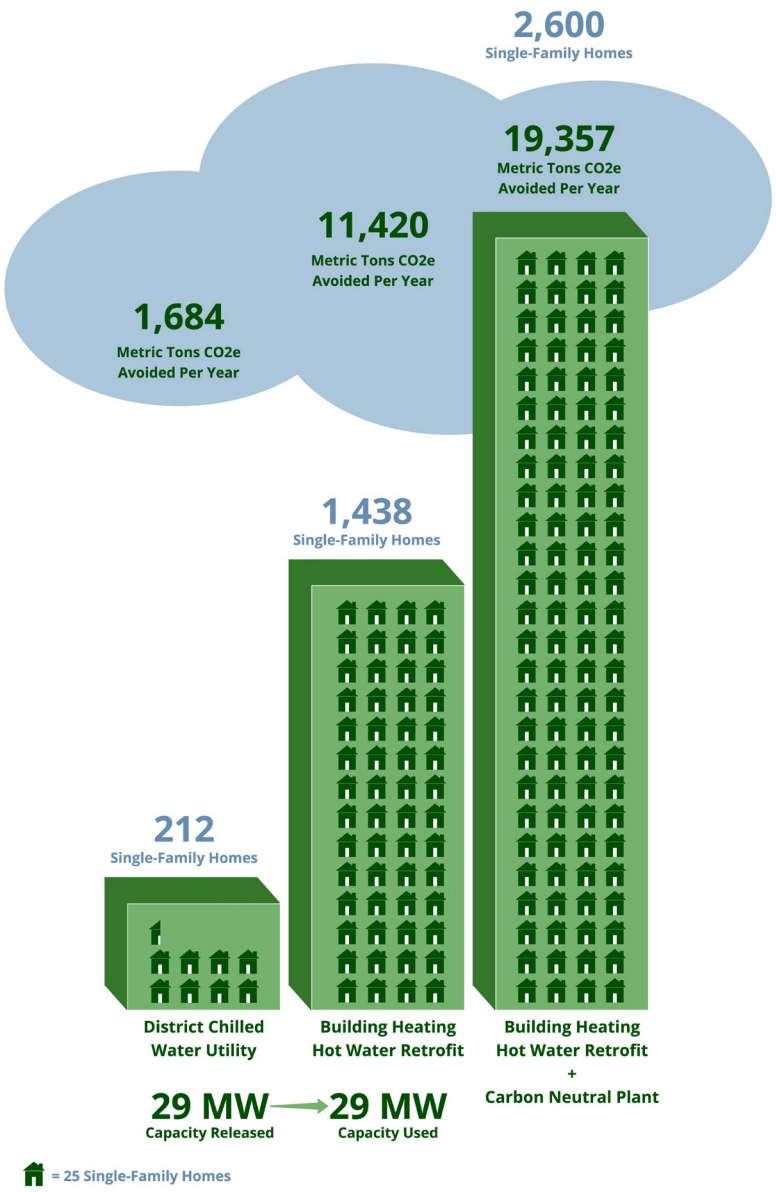


measures or participation in a district energy system, it allows more headroom in electrical capacity to accommodate the needs of the future within the building.

As part of Arup's analysis, the team compared peak kilowatts released through chilled water load shifting to peak kilowatts needed per month to serve heat pumps providing hot water. While the resulting graph appears to indicate that kilowatt capacity during the winter months is insufficient (where the orange bars exceed a 29MW capacity limit), such intensity would be required only 5% of the time, during which other sources of power may be available to meet early morning demand.

With all that in mind, it appears buildings may achieve reduced carbon emissions not only by shifting onto the district energy system for chilled water, but also by gaining back sufficient electrical capacity to shift from gas-fired boilers to electric heat. Participation in demand response, energy efficiency and conservation measures, as well as energy storage, could further free electrical capacity for buildings.

As has been noted above, the potential for reduced carbon emissions through connection to a distributed district energy system for chilled water on Bunker Hill is significant, and that potential is made more significant with consideration of heat sources for those buildings involved. The opportunity to use freed electrical capacity to allow individual buildings to convert to heat pump space heating could save another 11,420 metric tons of carbon, or the equivalent to approximately 1,400 single-family homes. All in, the combination of shifting Bunker Hill cooling to a CenTrio plant to be served from 100% renewable energy sources plus a turnkey solution that helps those same buildings convert to heat pump space heating has the potential to reduce the local area's annual carbon emissions by the equivalent of more than 2,600 homes.



System Synergy with Affordable Multifamily Properties

While the mix of commercial, cultural and residential uses already make load leveling possible on Bunker Hill, a broader equity concern exists around smaller landlords—particularly for multifamily properties throughout downtown—who may not have the significant capital required to pay for the upfront and ongoing costs of electrification.

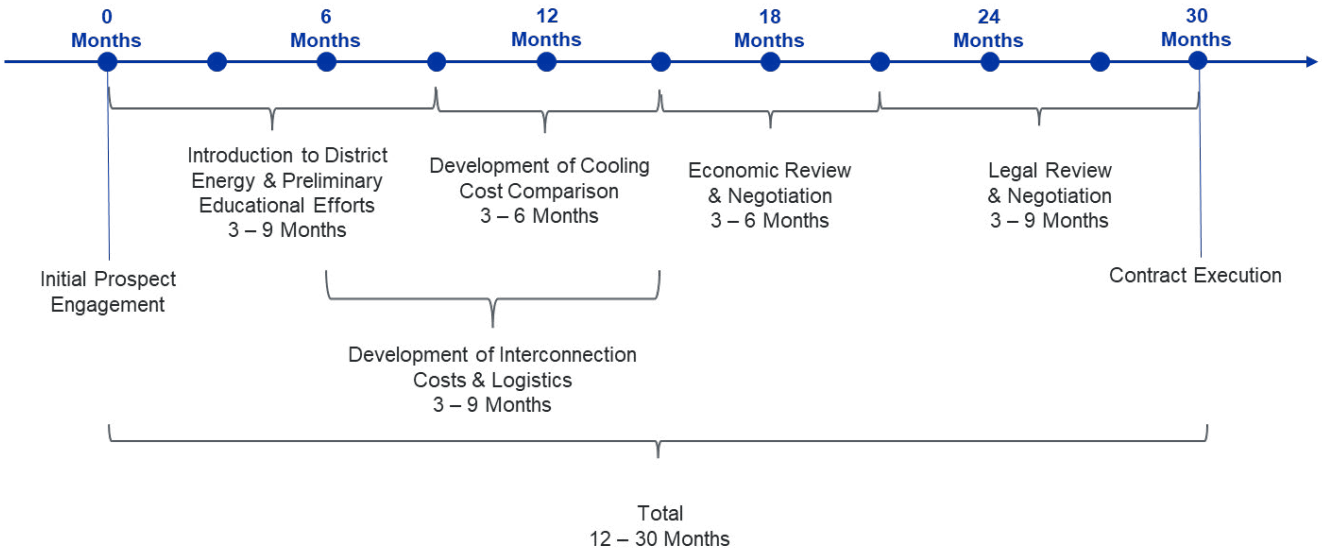
The panel reviewed a map provided by CenTrio of proposed expansion nodes and routes throughout the downtown area, noting locations where large-scale plants either already existed or where the potential load was sufficient to support a new one. The panel also considered the location of public lands and noted a compelling confluence of interests and infrastructure in the portal sites that L.A. Metro owns atop Bunker Hill adjacent to the CenTrio central plant facility, as well as at the southeast corner of First Street and Central Avenue in Little Tokyo. It became clear that the expanded system has the opportunity to encircle the Skid Row area, where a significant number of affordable housing and single-room occupancy building types are located. Ownership of these properties is concentrated with a relatively small number of owners, which suggests that effective collaboration could be possible.

Water Source Heating & Cooling as Climate Equity

The panel considered the potential of linking new or existing district plants with these properties through higher temperature chilled water "return" pipes of a two-pipe system to take advantage of its ability to serve as "condenser water" for both heat absorption and heat rejection. In this scenario, smaller multifamily buildings could be retrofitted to utilize electric water-source heat pumps for both heating and cooling, and domestic hot water could be generated by a water-to-water heat pump. This would limit interventions to consist of only piping distribution and electrical upgrades for small water-source heat pumps able to run on the single-phase power that is typically available within the units.

An important co-benefit of such a conversion is that older buildings, which typically have gas-powered furnaces and no air conditioning, would gain cooling as a result of installing water-source heat pumps. This would help to address an important equity issue, as low-income Angelenos suffer dramatically increased exposure to extreme heat.

Typical Project Development Timeline



Onboarding Customers to a District Energy System

Connecting new customers to the district system is, by necessity, educational in nature. Initial supplier and customer meetings focus on identifying the priorities of key customer stakeholders, including developers, building owners, property managers and operating staff. Building interconnection logistics and costs are established by the supplier to confirm a prospective customer building would be a good candidate for connection. Simultaneously, supplier and customer work to develop an understanding of a building's cost to cool with its own equipment, focusing on upfront capital, future capital, utility, maintenance, reliability, sustainability and labor costs. Once the value of the district connection has been established, the supplier and customer enter into a long-term service agreement that governs construction and service parameters.

Under the current model, each prospect is evaluated individually. Customers range in size and complexity from large multi-building campuses to small retail stores. Generally, the larger the customer, the further the piping can be extended to reach that building.

Low-income residents can gain access to cooling by connecting to the district system and converting to heat pumps

Current Pricing

Though it operates much like a utility, CenTrio is a private, nonregulated business. In Los Angeles, the energy company has a two-part rate structure comprised of both a service fee and a consumption cost. The service fee includes capital costs associated with connecting a building to the system, amortized against the length of the contract, such as laying pipework to bring chilled water to the building, as well as a facility maintenance fee of $1,800 per ton for future upkeep of the system. Consumption costs are based on energy use per ton hour for chilled water. CenTrio funds general upgrades, including for expansion to the system, with its own capital.

Expanding a district energy system—physically laying the pipe required to carry chilled water to and from each participating building—requires working underground. In an urban area as busy as Downtown Los Angeles, significant coordination is needed for any such project. CenTrio estimates that, depending on pipe size, extending existing lines could range roughly from $12 million per mile to $20 million. Another way to consider the cost in a compact region such as Downtown Los Angeles might be by trench foot. As of the publication date of this report, the national average cost per trench foot was $3,500, while the cost per trench foot in Downtown Los Angeles was as much as $10,000, according to recent cost estimates for pipe extensions to connect buildings to the Bunker Hill system.

Existing Educational Programs & Financial Incentives

Collaboration with building owners will be key to developing a robust district system, especially as it relates to the connection and construction of satellite plants. How effectively CenTrio can collaborate with government bodies and utilities such as the City of Los Angeles and LADWP, as well as with community and business groups, is also critical to the successful expansion of the system.

L.A. Better Buildings Challenge (LABBC)

The LABBC, a U.S. Department of Energy-affiliated program funded by LADWP and operated by local sustainability firm Sustento Group, provides a platform for collaboration around decarbonization opportunities within the real estate sector and serves as a bridge between real estate, policymakers and utilities. In addition to its role as a connector, LABBC also provides project development support, regulatory compliance planning, incentive application assistance, education and opportunities for recognition to participating buildings.

LA Department of Water & Power (LADWP)

LADWP, the nation's largest municipally owned utility, provides electricity and water throughout Los Angeles and offers a range of incentives for energy and water efficiency, as well as for renewable energy generation.[15]

SoCalGas

SoCalGas is the natural gas utility in Los Angeles, and similarly offers a range of incentive programs. In addition, SoCal Gas has plans to invest $400 million in clean fuels and infrastructure by the end of 2025, with specific initiatives and pilot projects targeting hydrogen-based energy production.[16]

15 "Rebates and Programs," Los Angeles Department of Water and Power, 2022

16 "Leading Through Sustainability," SoCalGas, 2022


Bank of America
PAUL HASTINGS

RECOMMENDATIONS

The panel believes the recommendations that follow would make development of a distributed district energy system significantly more cost effective, less time intensive, more inclusive, more efficient, and ultimately, more impactful. While connecting to such a system may not make sense for all buildings, the role it could play for those with aging, inefficient plants—and for new construction—is significant.

1. Enhance the Existing Bunker Hill Plant

In consideration of the four key themes presented to the panel, one important insight underpinned it all: enhancing the existing Bunker Hill district energy system and expanding it into a distributed system that connects multiple plants throughout Downtown Los Angeles would catalyze broader decarbonization of the urban core. Given the City of Los Angeles' commitment to curbing carbon emissions, building out such a system is exactly the kind of big idea needed to kick-start meaningful progress toward net zero.

While the potential benefits of connecting additional buildings to the existing plant are compelling, the panel identified several opportunities to enhance the Bunker Hill district plant which, if implemented, could add significant value for customers and the grid.

- **Thermal Energy & Electricity Storage:** Space within the existing plant could be repurposed to house thermal storage or batteries, which could be used to enhance load-shifting capabilities and/or provide back-up power in the event of an outage.
- **Onsite Clean Power Generation:** Similarly, space within the existing plant could be repurposed to house fuel cells and/or combined heat and power systems to generate clean power within a compact footprint.
- **Offsite Clean Power:** The plant could operate on 100% clean power if CenTrio were able to interconnect offsite renewable energy assets that its parent company already owns.
- **Advanced Cooling Tower Water Management:** Cooling towers serving the plant could be upgraded to increase water efficiency and reduce operating costs.
- **Integration of Customer-sited Distributed Energy Resources (DERs):** While space within the district plant is limited, several customer sites have sufficient subterranean space to house chilled water and/or ice storage systems that could enhance the efficiency and resilience of the overall system. Building-level chillers and heat pumps could also be integrated into the district loop, to enhance the resilience and efficiency of the system.
- **Enhance Resilience:** To create further resiliency while also meeting increased demand on the electrical grid due to a ramp up of building electrification and the proliferation of electric vehicles, a third electrical feed into the Bunker Hill system will be essential. 2. Expand the Bunker Hill Plant into a Distributed District Energy System

"We are interested in all potential options to provide the most efficient and clean energy solutions."

– CenTrio Energy

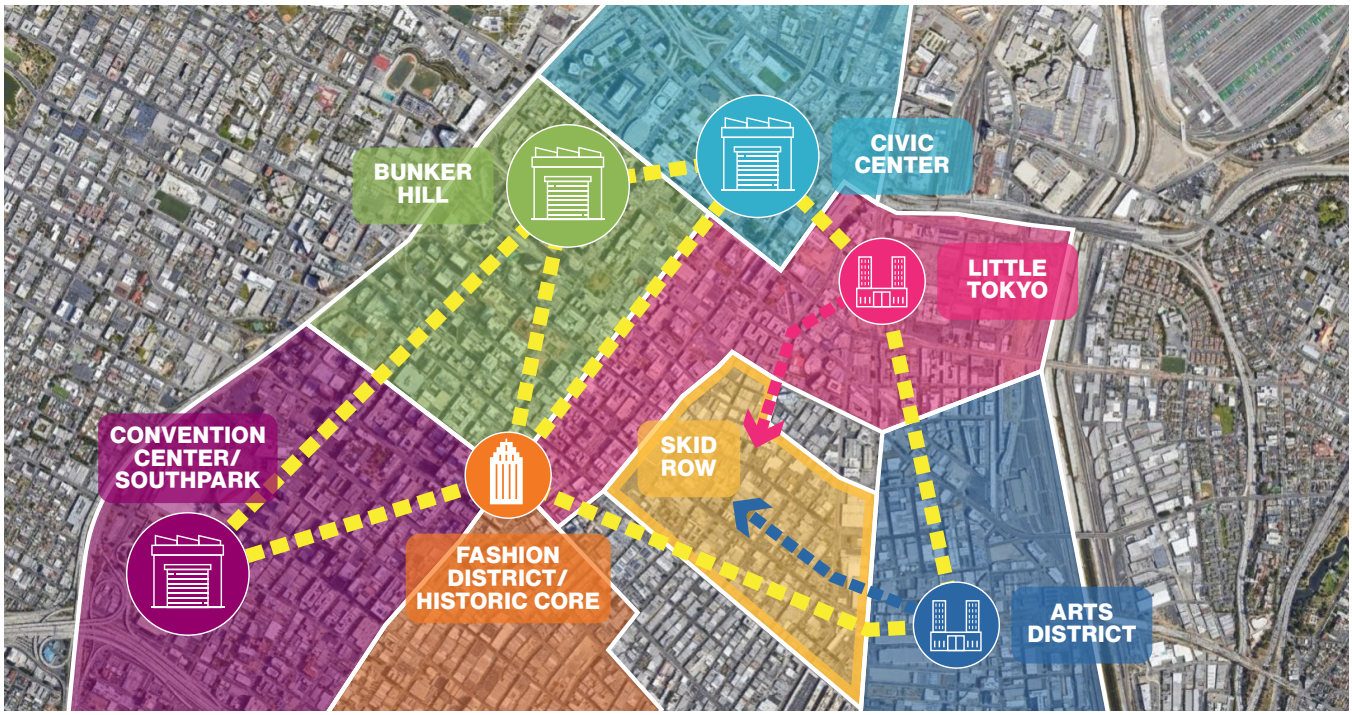
2. Expand the Bunker Hill Plant into a Distributed District Energy System Serving Downtown Los Angeles

Connecting additional satellite plants to expand the existing Bunker Hill system would amplify environmental, operational, and social benefits, and accomplish multiple objectives at once. Not only would the expanded system be more resilient, but it would also be more efficient and enable a more equitable energy transition by bringing piping closer to smaller buildings that would otherwise struggle to decarbonize.

When planning sites for future plants, it will be important to bear in mind proximity to utility infrastructure and, beyond that, to understand LADWP's maintenance and upgrade plans. This is important to ensure not only that electrical capacity is sufficient, but that circuits would not be overburdened. Aligning district plant locations with new substations would maximize resiliency and could put the district energy system in a position to support large-scale implementation of grid and on-site renewable energy, as well as localized energy storage and system load balancing in alignment with LADWP operations.

The distributed district energy concept, where assets producing supplemental chilled or hot water are located within buildings served by the network or in distributed mini energy plants, offers an opportunity to further improve resiliency. More chilled or hot water assets on a network provides more reliability should assets fail or otherwise be inoperable, for example, due to maintenance. Further expanding the network also offers the opportunity to create more pipework loops, offering additional advantages should a district energy pipe be damaged for any reason. In that case, water could be redirected around the remaining portion of the loop to continue serving the load.

Another key factor to bear in mind when evaluating potential expansion routes is social equity. As noted above, expanding the network through low-income communities like Skid Row can create important synergies that improve efficiency, enhance resilience, and address cooling equity.



1995 Began Operations
130 Customers
53 Million SF Served
5 District Plants
1 Satellite Plant
16 Miles of Piping

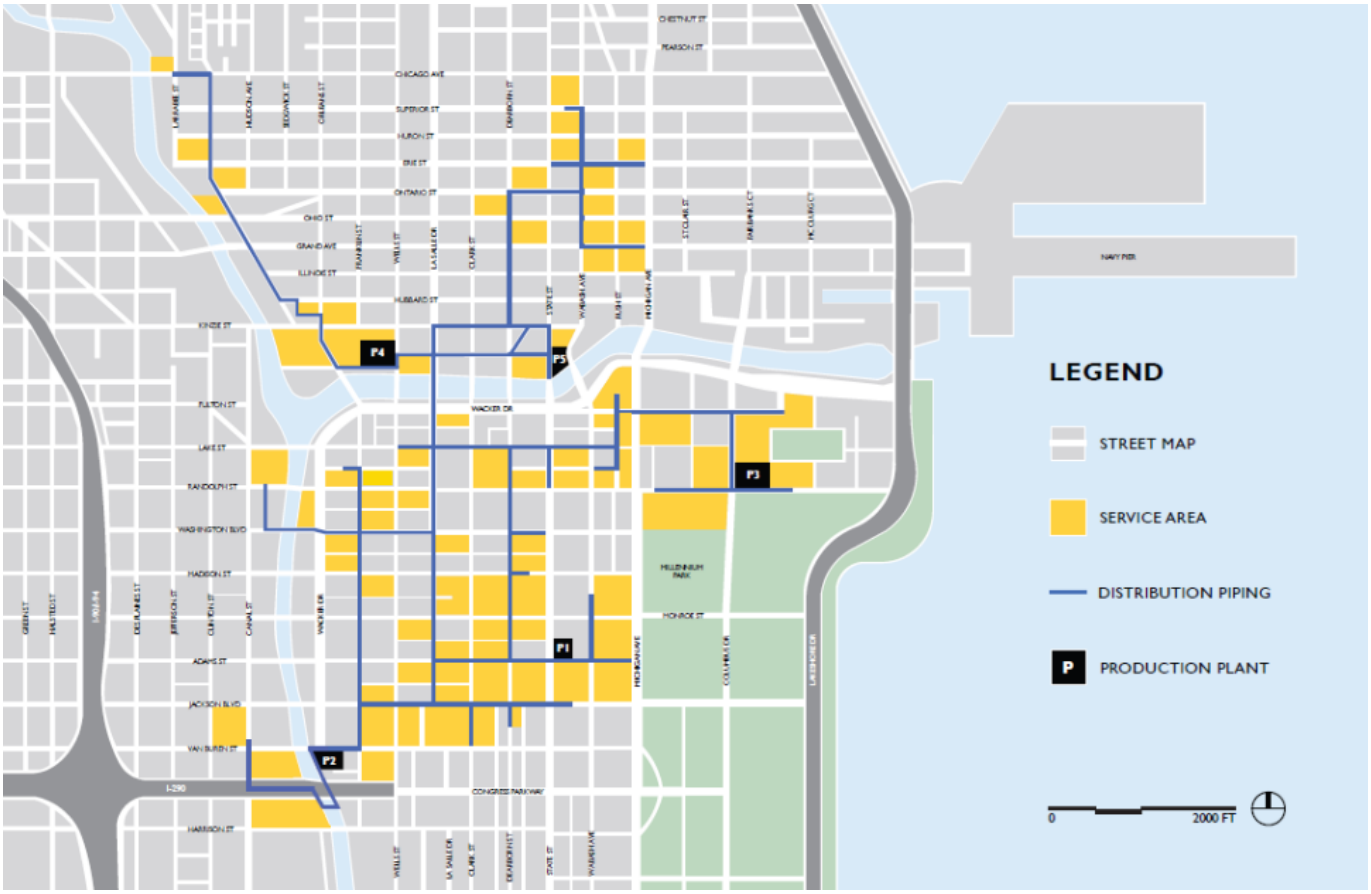
CASE STUDY: CHICAGO DISTRICT ENERGY SYSTEM

Overview

CenTrio's Chicago system operates North America's largest ice battery system to produce ice at night, reducing energy costs and greenhouse gas emissions, and leverages the nearby Chicago River for heat rejection, offsetting 143 million gallons of freshwater consumption annually. CenTrio's service uptime record of 99.99% provides its Chicago customers with unparalleled reliability across the commercial, residential, hospitality, entertainment and data center sectors.

Key Learnings

- In coordination with (re)development projects, it is possible to increase the number of buildings served by a district energy plant over time, and to connect multiple plants in an urban area.
- Generally, the larger a customer building, the further the district can be extended to reach that building. Expanding the system in this way brings infrastructure closer to small buildings, making it more cost effective to connect them to the system.
- Significant educational efforts are required to establish confidence in district systems within the real estate community.



Building a Cohesive System

Preliminary system planning began in 1993, following deregulation of the cooling market in Illinois and execution of a non-exclusive use agreement with the City of Chicago. Concurrently, technical reviews began to optimize technology selections and construction methods for Plant 1, initial customer sites and the distribution network. Initial customer contracts were signed in early 1994 in preparation for Plant 1 construction.

The five distribution plants currently serving the district system were initially built to serve select neighborhoods and were connected to one another over time as new customers came online between these neighborhoods. Interconnection of multiple plants provides additional reliability and economic dispatch options, creating value for customers and CenTrio.

Achieving Market Buy-In

Prior to the CenTrio system, no district cooling system existed in Downtown Chicago. Significant educational efforts were required to establish confidence in district systems within the real estate community. Pre-development efforts included assembling a team of consultants and suppliers with experience in district system management, development, design, construction and operations. Business development professionals were hired to begin promoting the benefits of district cooling in Chicago. Marketing materials were developed and key leaders in Chicago were hosted on trips to other cities with district systems.

3. Catalyze Expansion by Connecting Public Buildings and Encouraging District Energy in Requests for Proposal to (Re) Develop Publicly Owned Property

Connecting Public Buildings to the District Energy System

Host to the largest concentration of government employees in the nation outside of Washington, D.C., Downtown Los Angeles has an abundance of publicly owned property. Concentrated most heavily in the Civic Center, public property downtown is owned by all levels of government—city, county, state and federal—for a variety of purposes, including offices, courts, municipal services such as transportation, fire and police, as well as public open space. Certain properties at every level of government may be suitable for connection to a central plant, as shown in the map on the opposite page.

Potential Benefits of Connecting Existing Public Buildings:

- Anchor expansion of the district cooling system eastward
- Test processes, build partnerships
- Realize energy, expense and GHG savings
- Enhance cost-effectiveness of connecting private buildings
- Lead by example

Integrating District Energy into the Public Sector RFP Process

A significant portion of publicly owned land is occupied by existing buildings, much of which is slated for redevelopment with a focus on the creation of affordable multifamily housing. The panel further recommends that policymakers consider leveraging redevelopment opportunities on public land where central plants exist, or are planned, to require connection to or creation of district energy infrastructure.

The panel's hypothesis is that such an approach could

City Property (Green)	County Property (Purple)	State Property (Blue)	Federal Property (Yellow)
1. Figueroa Plaza 2. LADWP HQ 3. LAPD 4. LA City Hall 5. City Hall East 6. City Hall South 7. LAPD Detention Center 8. LA Dept. of Transit 9. LA Central Library 10. Pershing Square 11. City Garage 12. City Emergency Operations Center and Fire Station 13. Olvera Street Park and Historic Site (City and County) 14. City Park Site	1. LA County Hall of Administration 2. LA Superior Court 3. County Garage (Underground) 4. LA County Hall of Records 5. LA County Central Plant 6. LA County Criminal Court 7. LA County Hall of Justice 8. County Jail Facilities 9. County Music Center 10. LA Metro HQ* 11. Bunker Hill Metro Station* 12. Little Tokyo Metro Station* 13. MTA Bus Facility* 14. Walt Disney Concert Hall 15. Grand Avenue Project * MTA Property	1. CA Dept. of Transit 2. Ronald Reagan State Office Building 3. Junipero Serra State Office Building 4. MWD HQ (Regional)*	1. US Courthouse 2. US Courthouse 3. Federal Building 4. Edward R. Royal Federal Building 5. Federal Detention Center

not only help to create the critical mass necessary for the success of a district energy strategy, but also reduce construction costs in the short term while supporting decarbonization and energy affordability in the long term, especially for affordable multifamily housing projects. Integrating opportunities for district energy into the public RFP process might look like:

- **Including District Energy in RFP Goals:** Especially in cases of public-private partnerships, where the public sector supplies the land and the private sector supplies development expertise, an RFP typically begins by outlining goals for the site, the use(s) the public agency responsible for the site wants to see the property put to and the expected scale of development. Specific parameters the landowner wishes to see in the development may also be noted here, such as requirements for community involvement, design, employment, affordable housing or other specified amenities or uses.
- **Setting Parameters for Public Support:** An RFP usually specifies, in general terms, the way in which the issuer intends to make the site available, whether by sale, ground lease or some other means. In doing so, the RFP also makes public the parameters by which respondents will be evaluated and ranked. The RFP may also set forth to what extent the agency is willing to participate financially, for example, by selling or leasing the land at below market rates, issuing bonds to facilitate financing or undertaking to handle necessary entitlement steps in-house.

Such integration into the public (re)development RFP process could take a tiered approach, depending on the site and its proximity to existing or planned district energy infrastructure. Suggested tiers might look like:

- **Easy:** Tax incentives, partial subsidies, rebates and/or FAR bonuses for development on the property in return for connecting to existing—or building new—district energy infrastructure
- **Moderate:** Connection to any nearby existing district energy infrastructure is required in the RFP
- **Aggressive:** Connection or development is required in the RFP, and the developer must build it; developers keep the cost savings and, where possible, size the plant to supply additional properties in the vicinity

Potential Benefits of Integrating District Energy into the Public RFP Process:

- Increase the likelihood that such a system will be developed
- Catalyze expansion of the system to underserved communities
- Accelerate the timeline of build-out
- Facilitate coordination with related public works and infrastructure projects
- Access affordable public financing

4. Put a Price on Carbon Through a Citywide Building Performance Standard

The panel unanimously agreed that, without a price on carbon, many decarbonization projects don't "pencil," even with utility incentives. With an appropriate price on future carbon emissions, building owners can be incentivized to make investments today to avoid those costs in the future.

Policy Elements

The panel recommends that the City of Los Angeles consider the following elements as it moves through the stakeholder engagement process to develop a building performance standard:

- Ensure that compliance timelines are reasonable, but urgent, and that adequate notice is given.
- Provide for flexibility by allowing owners to use whatever technologies and operational strategies they decide are most effective and economical to meet the target.
- Set noncompliance penalties high enough to drive action without being overly punitive.
- Strategically reinvest any penalties collected into projects that further cut carbon emissions and/or contribute to climate equity.
- Align carbon budgeting, noncompliance penalties and timelines with similar policies in other major cities to the extent possible.
- Create a "resource hub" to help buildings develop projects and access incentives (see recommendation 6).
- Include natural gas or other "clean" alternative fuels such as hydrogen in parallel with electrification and develop a plan to ramp down or optimize usage over time.
- Require technical and financial feasibility analyses to connect existing public buildings within the projected service area to district energy systems.
- Require that new buildings be developed with infrastructure to enable connection to district energy, where feasible.
- Promote connection of existing buildings within the projected district energy service area.
- As part of any mandatory energy audit of existing buildings with 100 or more combined tons of cooling and/or which include a central plant, require technical and financial feasibility analyses of potential to connect to district energy.

CASE STUDY: COPENHAGEN DISTRICT ENERGY

Overview

Greater Copenhagen Utility (HOFOR) owns and operates an expansive district energy system that began operation in 1925.[1] Today, after almost a century of growth and development, the system is one of the world's oldest, largest and most successful district heating systems, supplying 98% of the city's heating requirements. District cooling is also provided to smaller subregions, including Copenhagen City Center and Kalvebod Brygge. In total, the 1,500-kilometer double-piped network connects 30,000 customers, or approximately 562,000 inhabitants. The system is supplied by combined heat and power plants (primarily natural gas and biomass cogeneration) and waste incineration facilities in the region, while district cooling relies on harbor water as an initial cooling source.

While HOFOR is publicly owned with the municipalities it serves each having a stake, the utility functions like a private company. The city therefore plays a role beyond that of simply being a customer; the city actively collaborates with HOFOR in development projects such as testing flexible heat consumption, optimizing domestic hot water tanks and establishing and running energy monitoring systems. The system has been successful in both lowering heating prices for consumers and reducing carbon emissions.

Private owners of existing and new buildings are required to connect to the district system and are encouraged to engage with the public agencies involved to develop methods to reduce consumption. In line with Danish energy policy, which aims to achieve a 100 percent renewable energy supply nationwide by 2050, HOFOR plans to integrate new technologies like electric heat pumps and heaters, geothermal heat and heat storage, alongside new means of renewable energy production. These strategies will be pursued together to develop a more flexible, dynamic district system with increased interaction between energy production and consumption.

1 "District Heating in Copenhagen: Energy-Efficient, Low-Carbon, and Cost Effective," HOFOR, 2016

Copenhagen Operates a "Mature" System

- The City of Copenhagen is the largest customer, leading by example
- Connection to the district energy system is strongly encouraged by the city
- Connection fees are assessed to the customer, whether they choose to connect or not
- Mandatory connection fees ensure long-term revenue for the district energy provider
- Utility rates incentivize customers to operate efficiently
- Metering supports transparent and accurate billing
- District energy rates decline over time as the system grows and gains efficiency

Key Learnings

- Transparency and alignment of incentives between the district energy provider and customers drives efficiency throughout the system
- Participation of public buildings provides systemwide benefits
- Public-private partnership provides an effective regulatory and economic framework

Thermal Storage in Denmark

Wind farms in Denmark, for example, both on-shore and off-shore, generate more electricity than the country needs. Using large industrial heat pumps and massive underground thermal storage systems, the Danes channel that excess renewable energy into heating or cooling, depending on the season, and store the thermal energy in underground systems until it is needed, often three to six months at a time.

5. Create an Entity to Coordinate Expansion of the System in Concert with Other Infrastructure Projects

More than a promising proposal, the idea of a distributed district energy system could be so foundational to large-scale decarbonization that the panel believes public and private sector should come together to accelerate its expansion.

Whenever possible, CenTrio looks for creative cost saving solutions to project development, such as running pipes through nearby parking structures or underutilized basement spaces in neighboring buildings. While these types of arrangements can open opportunities for building owners within the district to garner additional revenue and more easily connect to the district system, they also add complexity to each project.

Piggybacking on public infrastructure projects could significantly reduce connection costs by reducing permitting and construction costs, accelerating timelines and ultimately realizing the benefits of distributed district energy sooner. This approach could further benefit the community by incorporating piping for other uses, such as hot water or high-speed fiber optic cables. Thus, one important role of a collaborative body would be to track all other in-street construction projects so that, wherever feasible, piping for the district energy system could be installed while streets are opened for other below-grade installations.

The panel recommends creating an entity to facilitate cross departmental collaboration, align major planning objectives and coordinate infrastructure investments with the growth and development of distributed district energy infrastructure. This entity could reside within a city department or, alternatively, the city could create a public-private energy conservation corporation with the express task of tracking all existing and proposed centralized energy projects throughout the city.

Potential partners in this collaboration may include, but not be limited to, representatives from:

- Los Angeles Department of Water & Power (LADWP)
- Los Angeles Bureau of Sanitation
- Los Angeles Department of Building & Safety (LADBS)
- Los Angeles Housing Department (LAHD)
- Housing Authority of the City of Los Angeles
- Other City of Los Angeles Departments
- LA Metro
- Los Angeles County
- Green Bank
- Private Organizations & Trade Associations

Enhanced Infrastructure Financing District

One such entity that may serve this recommendation well is an enhanced infrastructure financing district (EIFD), which can be created by local governments to help fund economic development projects that address conditions impacting public health (air or water quality, for example) or extreme weather events (sea level rise, heat waves, wildfires, etc.). The panel believes that, as an initiative with an objective to move toward a 100% renewable energy future and, in doing so, address the increasing need for air conditioning among low-income residents as a matter of public health, a proposal for a distributed district energy system would well qualify to create such an entity.

EIFDs are typically financed by a form of tax increment funding for a fixed period (not to exceed 45 years), wherein the additional property taxes generated by development induced, supported, connected to and improved upon by the infrastructure is directed toward paying for the infrastructure rather than into a more general fund. Typically, the improvements are financed by public bonds, which can often be issued at preferential interest rates and be repaid by the incremental taxes assigned to the district. While an EIFD is created by one or more public entities, it is itself a separate public entity.

Benefits of an EIFD

- Power of Eminent Domain: An EIFD may, where needed, acquire property for the facilities it finances through eminent domain.
- Financial Depth: As a public entity, an EIFD would have the ability to receive tax revenues, allowing the district to be less reliant on direct revenues than even a large corporate entity would be in undertaking a substantial capital investment.
- Operational Control: An EIFD can have a board of directors, or a governing board, that includes representatives of the affected properties, allowing for critical oversight and ensuring optimal collaboration.
- Coordination: Such a district could contract with one or more operators to deliver chilled water and other utility services, and it could also work with key property owners to coordinate connections to existing buildings not yet on the district system. The district would also work with stakeholders to establish guidelines for future buildings—both public and private—expected to be developed nearby.

6. Create a "Resource Hub" to Help Customers Evaluate the Feasibility of Connecting to the District Energy System, with Additional Services for Smaller Buildings

Keeping in mind the city's commitment to an equitable energy transition, one of the panel's key concerns was to empower a wide array of buildings to participate in the benefits of a distributed district energy system. To address this issue, the panel recommends the creation of a "resource hub" that would provide free technical assistance to help customers evaluate the feasibility and cost/benefit implications of connecting to a district system. Such an entity would be particularly important for onboarding smaller, less well-resourced buildings onto the system.

Services might include:

- Education and outreach[2]
- Utility benchmarking support
- Incentive and rebate screening
- Project pre-development support
- Physical site assessments
- Contractor directories and procurement support
- Connection to financing options
- Tenant engagement services
- Temporary relocation services

The LABBC currently provides many of these services through its Energy & Water Efficiency Resource Center.[3] This work could be expanded, or the LABBC could partner with new entities created or contracted to perform specific related functions.

2 Including online tools and resources to help customers understand required scopes of work, upfront investment and pathways to implementation

3 The Resource Center, BetterBuildingsLA.com

7. Enable Interconnection of Privately Owned Offsite Renewable Energy

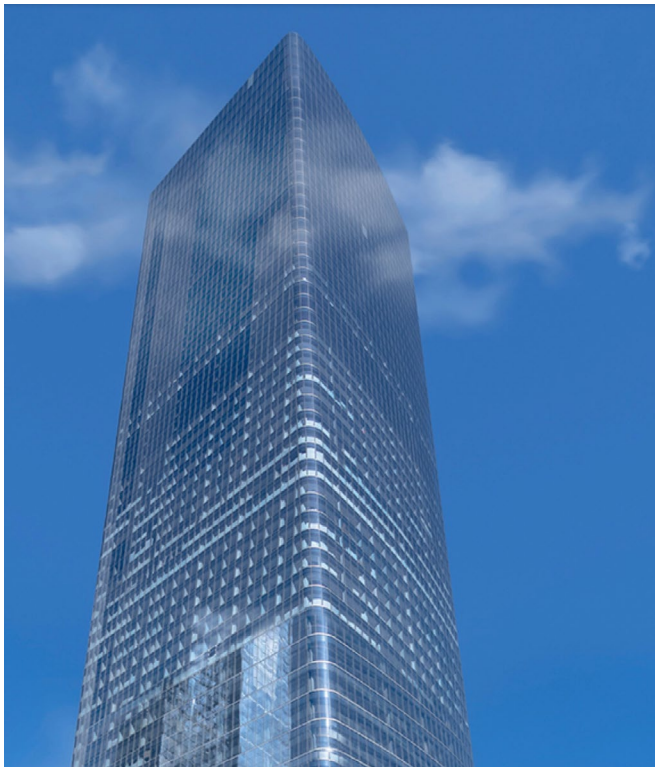
While the district cooling scheme addresses some of the most significant demand-side issues, achieving net zero carbon from building operations will require that remaining electrical loads be served by renewable energy. Though LADWP currently offers a range of programs to expand customer-sited renewable energy generation, space limitations often make it challenging to meet a significant portion of a commercial building's load. And while LADWP is making significant investments to decarbonize electricity supply, the pace of the transition is too slow for customers whose internal climate targets call for more rapid decarbonization. Thus, the need for Renewable Energy Credits (RECs), participation in green power programs and interconnection of privately owned off-site generation remains.

The validity of many RECs has been called into question, making that strategy unappealing to customers whose investors and other stakeholders need confidence that reported greenhouse gas reductions are defensible and durable. Panelists heard from several stakeholders that LADWP's green power program is also a tough sell, due in part to the cost, but also because of the lack of apparent connection between a $0.03 per kWh premium and specific tangible renewable energy projects. This leaves interconnection of privately owned off-site generation, which according to panelists familiar with the matter, LADWP's charter currently prohibits.

With a total projected price tag of $57 billion to $87 billion[4] to achieve a 100% clean energy supply between 2035 and 2045, there is a missed opportunity in not enabling building owners to connect privately owned offsite renewable energy assets. To support private sector investment, customers should be incentivized to use energy generated offsite for their buildings' own use, and to tie any excess offsite renewable energy into a district energy system to serve other buildings. Furthermore, a favorable rate structure to transmit regional renewable energy assets owned by customers would also incentivize large-scale implementation of renewable energy.

A favorable rate structure to transmit regional renewable energy assets owned by customers would incentivize large-scale implementation of renewable energy.

4 LA100 Study, Link Here



100% Renewable Energy
2.1 Million Square Feet

CASE STUDY: INTEGRATING PRIVATELY OWNED OFFSITE RENEWABLE ENERGY

Brookfield to Power Manhattan Skyscraper with Renewable Energy from Upstate New York[5]

Real estate company Brookfield Properties announced in March 2022 that it plans to source[6] hydropower for One Manhattan West, a 67-story office tower in New York City built in 2019 as part of an 8-acre project. The five-year agreement with Brookfield Renewable Partners, another unit of parent company Brookfield Asset Management Inc., is one of the largest in-state renewable energy agreements for a single building in New York. Brookfield Renewable Partners operates more than 70 hydropower facilities and three wind farms in New York state.

Key Learnings

- Power Purchase Agreement (PPA) between generator and customer enables private investment to support citywide transition to renewable energy
- Interconnection agreement between utility and power generator covers technical issues and costs related to integration of offsite privately owned generation assets
- Customer continues to pay transmission and distribution costs as line items on utility bill
- Customers pays PPA provider for power consumption
- Enables customer to control progress towards corporate environmental commitments

5 Manhattan Skyscraper to Be Fully Powered by Renewable Energy, Bloomberg

6 Brookfield Renewable U.S. Press Release, March 21, 2022

8. Update Utility Rates and Incentives to Support Thermal Energy Storage and Load Shifting

Initial evaluations within LADWP territory show the potential for positive returns for thermal energy storage in tanks using stratified water, but a large amount of space or real estate is needed for such an approach. Still, these can work in different tank configurations, which may fit in underutilized or non-rentable spaces in older buildings, potentially unlocking dormant building value.

Evaluations of ice storage systems, which can take up less space than stratified water, have not favored well due to the added electricity needed to make ice, even during off-peak periods. A special rate or incentive for making ice or chilled water during off-peak times would improve the economics for such an operation.

As it stands, a "time-of-use" pricing structure means the cost for energy use during peak periods is greater than during off-peak periods, regardless of the actual cost of generation during that time of day. Solar energy is cheap and abundant during peak demand periods, but right now, because of an ordinance[7] that fixes the timeframe for LADWP's peak period, customers are "overcharged" for power during a time when the power is cheapest. While a time-of-use approach is logical and necessary to cause rational and economically driven behavioral change that reduces peak demand, the current structure makes energy and thermal storage projects financially infeasible.

From the perspective of the local utility, it would be worthwhile to evaluate the cost of installing more local renewable electricity generation versus incentivizing large-scale thermal energy plant operators to install thermal energy storage. The latter may be an unnecessary burden on rate payers, as the electricity generated during the peak of afternoon heating is low cost operationally, but high first cost, and the State of California is already exporting power to neighboring states during the summer because of lack of electrical storage capacity.

A recognition that battery storage is not the only beneficial load-shifting peak storage would show that there is a benefit to considering lowered rate structures for customers who are part of a smart-grid system of demand responsiveness, contractually committed to making chilled water during signaled low peak periods and releasing it on demand as requested by the utility during high-demand emergencies. Under all other normal operations, the building owner would have the right to deploy the chilled water at their discretion for financial and energy efficiency benefits.

Citywide programs providing for offsite renewable energy and onsite energy storage at scale can, with coordinated deployment, enable the local utility to:

- Coordinate with fewer entities to deliver renewable energy and storage,
- Enhance the overall cost/benefit equation while creating opportunities for large-scale load balancing and peak shaving and
- Provide resiliency options to optimize the local utility's operational efficiency and enhance its emergency response.

The panel recommends that a review of rate structures be considered that reduces operational costs for customers engaging in proactive, reliable, grid-supportive energy management, as a reverse parallel to the increased cost structures imposed on customers requiring high reliability or immediate power recovery guarantees from LADWP.

7 Press Release: "LADWP Board of Commissioners Approves Electric Rate Plan That Promotes Energy Conservation," May 6, 2008

2 Downtown Plants
36 Customers
43,000 Tons of Cooling
70,000 MMBtu of Heating

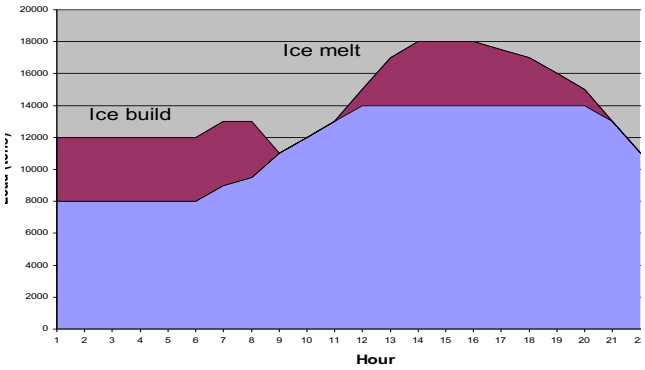
CASE STUDY: HOUSTON DISTRICT ENERGY

Incorporating Ice Storage into District Energy

CenTrio's Houston district energy portfolio includes two central plants serving 36 downtown buildings, including Minute Maid Park, the home of the Houston Astros professional baseball team.

Houston's system successfully incorporates the use of a thermal energy ice storage system to provide backup capacity, increase reliability and keep utility prices in check. Ice is charged, or created, at night, tapping non-peak source energy pricing, and then drawn from, or melted, during the day to avoid demand for operating chillers during peak times. In Houston, this practice saves up to 80 percent on electricity during peak periods, and roughly $700,000 a year. From a decarbonization perspective, thermal ice storage also reduces carbon emissions within the district system by up to 15 percent.

Thermal Storage: Ice building and melting levels power demand.



Key Learnings

Thermal ice storage is a proven technology that reduces chiller size and shifts compressor energy, condenser fan and pump energy from peak periods, when energy costs are high, to non-peak periods, where electricity is more plentiful and less expensive.

Thermal storage provides backup capacity, thereby increasing reliability.

9. Create a "Green Bank" to Facilitate Public, Private and Philanthropic Investment

The availability of low-cost financing is critical to the success of a clean energy project of such scale and impact as that proposed on Bunker Hill. Reduced interest rates, extended term lengths and low or no money down financing options could go a long way to ensure that connection to a district energy system—and by extension, decarbonization—is not only attainable, but attractive, to potential customers.

The panel considered a variety of potential financing pathways to facilitate development of a distributed district energy system in Downtown Los Angeles, including:

- Traditional (Private) Financing
- Enhanced Infrastructure Financing District (EIFD)
- Community Facilities District (CFD)
- Green Bank

Private Financing

Under current conditions, private financing is the sole source of funding for the expansion of distributed district energy in Downtown Los Angeles. CenTrio invests its own equity capital, and sources traditional debt capital, to finance plant upgrades and project costs for connection to customers, as well as for new district plants. In certain circumstances, CenTrio might co-invest in projects that provide a mutually beneficial relationship with an industry collaborator to address more comprehensive sustainable infrastructure solutions, with a program manager working on behalf of an institution, or with a public entity in joint infrastructure districts. While private financing, whether from CenTrio or another source, should be part of the solution, the panel determined that it would be beneficial to find ways to leverage public and philanthropic financing to bring down the cost of capital and better serve low- and median-income customers.

Enhanced Infrastructure Financing District (EIFD)

As noted previously, EIFDs can be created by local governments to help fund and govern economic development projects that address public health or extreme weather. However, because EIFDs are typically formed by cities, they tend to have a limited revenue base: the City of Los Angeles' share of property tax is quite small at less than $0.20 per $100 of assessed valuation.[8] This means that EIFDs are most often formed only when the county agrees to pledge its share of property taxes, or when a project is very large. Under current law, EIFDs are further limited to financing infrastructure projects and the development of affordable housing. While and EIFD could be useful to fund and coordinate certain pieces of the work, given that the full scope of the project is not fully defined, the process to form an EIFD could take several years, so the need for a faster more flexible solution remains.

Community Facilities District (CFD)

A CFD is a special taxing district formed with the approval of a city[9] to finance public infrastructure through the issuance of tax-exempt bonds. The bonds are repaid through special taxes levied on properties within the CFD's boundaries, which cannot be based on value, and with no obligation to tax all properties equally. To encourage an equitable connection to district energy in Downtown Los Angeles, it might be that affordable housing or small local businesses pay a lesser tax. However, much of the infrastructure would be private and, as with an EIFD, before the city can issue the CFD bonds a plan must be submitted for approval to delineate the boundaries of the area and specify in detail the improvements to be funded. Furthermore, forming a CFD requires a vote of the district's residents, which would be challenging in a densely populated area such as Downtown Los Angeles.

The use of public financing, even when there are financing savings, adds time and complexity to development processes that are already quite daunting in Los Angeles. Without technical help and increasing scale, the financial savings alone are not worth the effort.

8 By way of example, a 200,000-square-foot office building valued at $300 per square foot would have an assessed value of $60 million. At that value, the city share of sales tax would be $120,000.

9 The term "city" here refers to whichever government exercises direct municipal governance, which would be a city except in unincorporated areas where a county would exercise city functions.

Green Bank

Ultimately, the panel concluded that a green bank would likely provide the greatest benefit to a project of this scale and complexity. The Coalition for Green Capital (CGC), a nonprofit green bank advisory organization, defines green banks as "mission-driven institutions that use innovative financing to accelerate the transition to clean energy and fight climate change."[10]

Green banks are often established to complement existing financing institutions by attracting and mobilizing private capital that might otherwise be unavailable to a particular market or segment. Because green banks use financing rather than grants, capital is expected to be returned or repaid. This approach ensures that green banks focus on markets with reasonably good potential for payback, typically in proven, technically viable projects that are well past the stage of research and development.

Each green bank is different, designed for local contexts to meet diverse objectives, such as to meet ambitious emissions targets, mobilize private capital, lower the cost of capital or energy costs, develop green technology markets, support local community development and create jobs.[11]

Establishment as institutions means that green banks are durable and can build up organizational culture and expertise. They have the autonomy to be flexible and responsive to the real world. In contrast to programs, institutions may try something, fail, and then try something different.

Benefits of a Green Bank

- Bridge the gap between capital and clean energy projects
- Provide a vehicle to meet pent-up demand from public and private capital providers
- Engage philanthropic and other non-traditional capital sources
- Serve low-income communities that are not well served by traditional financing
- Prioritize climate, equity and environmental justice goals

Nonprofit Model

Though green banks were initially predominantly public and quasi-public entities, independent nonprofit green banks now outnumber them.[12] The nonprofit model has proven preferable for many states and markets due to:

- Faster time to market
- Reduced burden to government
- Flexibility to draw on diverse sources of capital

Structured for capitalization from private, public and foundation dollars, the nonprofit model focuses on connecting clean energy projects to diverse sources of capital. While nonprofit green banks are not public entities, a strong partnership between the bank and government is critical for success. A small but meaningful commitment of public capital or other resources, for example, can be hugely beneficial in drawing philanthropic capital.

10 "What is a Green Bank?" Coalition for Green Capital

11 "What is a Green Bank?" Green Bank Network

12 "Nonprofit Model Memo," Coalition for Green Capital

Process & Timeline to Create a Green Bank

Much like the early startup phase of any institution, the creation of a green bank typically involves[13] an evaluation of the market, engagement of capital providers, development of a business plan and the procurement of startup funding. Once institutional processes are put in place and an initial product is launched, eventual expansion may take place through additional products and sectors.

With a narrow focus on accelerating the clean energy transition, green banks have timing top of mind. In contrast to programs that make capital available passively, green banks aim to maximize market penetration as quickly as possible to displace "dirty" energy.

1. Evaluate market to identify investment pipeline
2. Engage potential capital providers
3. Write a business plan with financial statements
4. Raise startup funds
5. Create product concepts to suit target pipeline
6. Secure capital for lending
7. Build out the team and operation
8. Launch the green bank

13 "Introduction to Green Bank Development in the U.S.," Coalition for Green Capital

"Ultimately, green banks aim to fight climate change. We have a narrowing window to accomplish an effective energy transition if we are to avoid the worst impacts. The accelerated adoption of clean energy facilitated by a green bank is a powerful and cost-effective part of a full climate policy platform."

— Coalition for Green Capital

California's Green Bank

The State Treasurer's Office serves as California's Green Bank. The office invests a portion of funds from the Pooled Money Investment Account (PMIA) in bonds that finance green projects throughout the world. It also operates two authorities charged with financing and administering programs that promote green jobs and green California industries, keep our air and water clean, and support greenhouse gas reduction by facilitating financing for energy efficiency and encouraging the use of alternative energy: The California Alternative Energy and Advanced Transportation Financing Authority (CAEATFA) and the California Pollution Control Financing Authority (CPCFA). By establishing a local green bank, Los Angeles can leverage state resources with local capacity, capital and expertise.

IMPLEMENTATION

Phase 1: Connect

To catalyze the expansion of a distributed district energy system across Downtown Los Angeles, significant barriers must be addressed. Public and private sector leaders alike must make it a priority in the near term to connect, communicate and collaborate to unlock the potential benefits behind the recommendations identified by the panel. Below are suggestions for actionable next steps.

Collaborate with LADWP

Collaboration with LADWP will be crucial from the outset of any endeavor to expand and optimize a distributed district energy system. To facilitate this, next steps might include:

- Sharing findings of this report directly with utility staff to discuss alignment with LA100
- Hosting conversations between LADWP and large customers to discuss rates, incentives and potential for interconnection policies with the benefit of customers' real-world projects for context

Communicate Policy Recommendations

Efforts should also be made to convey the recommendations within this report to the City of Los Angeles and other policy professionals, especially regarding carbon pricing and opportunities around public land. City leadership and support for this initiative are key for customer and utility buy-in. Near-term meetings with City Council and department staff might discuss:

- Elements of a building performance standard
- Connecting municipal facilities to district energy to ensure the city leads by example
- Requiring development projects on public land to connect to district energy
- Permitting and coordinating district energy efforts with public projects to drive cost efficiencies
- Exploring financing opportunities, including a public support for a local green bank

Connect Customers and Plants

Nearby Buildings

Beginning efforts to recruit additional nearby buildings to the existing district energy plant on Bunker Hill will be an important early step in expansion efforts. Feedback from early adopters could be instrumental in:

- Testing panel recommendations in the market
- Refining messaging around the value proposition and logistics of connecting to the system
- Serving as case studies to support expansion conversations
- Communicating progress and showing synergy between public and private sectors

LA County and LA Convention Center Plants

Exploring opportunities to connect existing central plants to expand the system is another logical next step, and the plant owned and operated by Los Angeles County may be a promising addition. Linking up with the county's system, which is the closest potential satellite plant that exists near the Bunker Hill system, could bring service east to the Civic Center and toward a concentration of city, county and federal buildings. This would not only add resilience to the system, but it would also create momentum for expansion to other nearby neighborhoods, such as Skid Row. Such a public-private partnership might also provide access to funding opportunities or other mechanisms and resources that may otherwise not be available to such an endeavor.

The project team should also test and map challenges and opportunities as they relate to connecting with other downtown central plant locations. The Los Angeles Convention Center, for example, might prove another promising pathway, to bring district energy service to buildings along Figueroa Street.

Phase 2: Further Study

Due to the limited timeframe allotted for a ULI TAP, the panel noted several areas for further study.

Technical Potential

Due to limitations on time and data, the panel's technical exploration of district energy was constrained to the potential for expanding the Bunker Hill system's existing chilled water loop and its synergy with connecting multifamily residential buildings. To model the technical potential of such a system more accurately, efforts should be made to further develop the energy study Arup initiated to include real building data for a broader cross section of properties on Bunker Hill and throughout downtown. Ideally, the study could make data-driven projections about the capacity of the entire expanded system, how many buildings could be connected and the overall economic, environmental and social impacts. Opportunities to optimize or maximize the system by adding hot water or repurposing waste heat should also be explored. To achieve this, further funding will need to be secured.

Opportunities for further study include evaluation of:

Chilled Water Loop

- Real data on existing central plant equipment, operations and performance
- Potential enhancements to the central plant, such as thermal or other energy storage
- Opportunities for integration of customer-sited distributed energy resources (DERs) into the district system

Hot Water Loop and Waste Heat

- Potential uses for hot water
- Business case for reinvestment by CenTrio
- Replacing boilers with heat pumps
- Options for waste heat capture

Expanded System Impact

- Overall contribution to citywide sustainability goals, especially as it relates to kilowatt hours, kilowatts, gas, greenhouse gas emissions and water
- Incentives and rates that could enable or encourage private investment in the system
- Potential expansion pathways, such as nearby basements, sewer systems or Metro lines, and other planned infrastructure projects
- Sites for potential satellite plants to connect to the system, both new (such as on public development or redevelopment sites) and existing (such as the LA County or LA Convention Center plants)
- Financial and technical feasibility to expand infrastructure to reach affordable multifamily residential customers

Connecting High-Performance Buildings

One of the key hypotheses the panel explored was that connecting high-performance buildings and customer-sited distributed energy resources (DERs) to the district cooling loop could create value for all parties—for the central plant operator, for buildings connected to the loop and for the city overall. While the theoretical potential appears promising, there are significant barriers to realizing that potential, including:

Barriers:

- Operational Control: HVAC must be carefully managed to conform with the terms of lease and financing agreements, as well as to manage expenses and meet corporate ESG goals. For these and other reasons, many real estate owners prefer to own and operate building-level heating and cooling plants.
- Relative Efficiency: While a district cooling plant is highly efficient, some owners have invested in super-efficient heating and cooling systems that are more efficient, reducing the value proposition of connecting to a district system.
- Customer Ability to Monetize DERs: While there is technical potential for high-performance buildings to connect DERs that would contribute to the efficiency and resiliency of the district system (e.g., super-efficient chillers, heat pumps, batteries, thermal energy storage systems), the economic and legal model for doing so remains unclear.

Further study is needed to model the potential economic, environmental and operational impacts of a distributed district energy system that includes high-performance buildings and customer-sited DERs. The ability to realize the potential benefits depends on several factors, including development of:

- New contracts and financing structures
- New business models
- New utility incentives, policies and rates

Connecting Smaller Commercial Buildings & Multifamily Residential Properties

Additional research is likewise needed to understand the full impact of connecting smaller buildings, especially multifamily properties, to a distributed district energy system. A particularly promising area of study that the panel identified was in the synergy between district chilled water efficiency and the potential for connection of residential buildings retrofitted to water-source heat pumps.

Funding would need to be secured to analyze the scope of work required to retrofit existing multifamily properties to connect to district energy infrastructure, including a cost-benefit analysis. A similar analysis would be beneficial as it relates to new construction.

Opportunities for further study include evaluation of:

- Scope of work to retrofit multifamily units from gas-fired furnaces to water-source heat pumps, including ancillary costs
- Potential expansion routes for a district cooling loop to optimize cost benefit and maximize opportunities to connect affordable multifamily properties
- Potential health and social impacts of increased access to cooling for low-income customers

Financing Strategies

Some form of financial support will be needed to accelerate the expansion of a distributed district energy system in Downtown Los Angeles. Such support would need to help building ownership not only overcome upfront costs of connection, but after connection avoid increasing tenants' utility costs. This financing, and/or subsidy, would be most critical to facilitate the connection of smaller or multifamily buildings to the system. The LABBC has conducted initial research into the nonprofit Green Bank model and is piloting a stand-alone financing model for affordable multifamily retrofits. More research is needed to determine viable potential funding models, sources of capital and delivery mechanisms.

Playbook for Other Cities

While every city is unique, the panel believes that the recommendations in this report can be adapted to apply to many municipalities.

- **Leverage Existing District Energy Infrastructure:** If a district energy plant already exists in your city, what is the potential to expand it? How do transportation or sewer projects overlay with the footprint of that system? If there is no district energy system in place, what would be some strategic potential locations for a new one? What existing infrastructure could be leveraged to create or expand a district energy system?
- **Engage Customers:** Does your city have an existing Better Buildings Challenge, 2030 District, EcoDistrict or similar initiative in place? Is there a strong ULI District Council? How can those groups work together to engages customers and other stakeholders?
- **Catalyze Expansion by Leveraging Public Buildings and Redevelopment Power:** Are city-owned properties in relative proximity to existing or potential district energy infrastructure? What opportunities could there be to leverage the public (re)development RFP process to promote expansion of a district energy system?
- **Put a Price on Carbon:** Does your city and/or electric utility have a stated net zero goal? What is the political environment? Who in city government could champion a policy? What is the city's capacity to develop and implement a policy? Who would be the key stakeholders?
- **Coordinate District Energy with other Infrastructure Projects:** Is there an entity that is positioned to coordinate infrastructure projects? If not, is there opportunity to create one as part of a revision to the city sustainability plan?
- **Evaluate Utility Rates and Incentives:** How do local utility rates help or hinder energy efficiency, load shifting and net zero aspirations? What financial or regulatory barriers stand in the way? What would be the process to update rates and incentives to support climate and resilience goals?
- **Unlock Opportunities for Private Investment:** Does your utility allow private power purchase agreements (PPAs)? What capital providers are active in your area? Could your city create a green bank?
- **Start the Conversation:** ULI Greenprint's global Net Zero Imperative is offering grants to help ULI District Councils explore these important questions through Technical Assistance Panels. Take the first step today by reaching out to ULI Greenprint.

CONCLUSION

Enhancing and expanding the Bunker Hill district energy plant could unlock a range of economic, environmental and social benefits with the potential for transformative impact. Through the process of exploring this opportunity, the panel hit on major barriers and compelling opportunities, developed new insights and uncovered exciting synergies.

We have the technology. We have the capital. Now, it's time for big ideas and bold action. ULI Los Angeles looks forward to working with the L.A. community to make this vision a reality.

ABOUT THE PANEL

Marty Borko, Co-Chair

Executive Director, ULI Los Angeles

Marty Borko is the Executive Director of the Urban Land Institute Los Angeles. Borko left his post as Principal at Gensler in Los Angeles to command the day-to-day workings and long-range planning of one of ULI's largest and most active regional chapters. As Executive Director Borko pilots the organization as it confronts the most critical land-use challenges in the city, including the homeless and housing affordability crisis, as well as city planning, infrastructure, transportation, open-space and historic districts.

In his tenure at Gensler's Los Angeles office, Borko grew the firm's Planning and Urban Design, Entertainment, and Mixed-Use practices and had been principal-in-charge on numerous international and Los Angeles projects.

In addition to being a Sustaining Member of ULI's Entertainment Development Council and member of the USC Price School Planning Program Advisory Board, Borko is: Associate Member, American Institute of Architects (AIA); Member, American Planning Association (APA); Member, International Council of Shopping Centers (ICSC); Member, International Association of Amusement Parks (IAAPA); Dean's Council, University of Oregon College of Design; Board Member, Los Angeles Downtown Breakfast Club; Member, Southern California Development Forum; and Member, Central City Association.

David Hodgins, MBA, MRED, LEED AP Co- Chair

Executive Director, LA Better Buildings Challenge,

With more than a decade of experience in project development, program delivery and policy implementation, David Hodgins is a recognized leader in the sustainable real estate field. He began his career with the Clinton Climate Initiative, where he led private sector project development for three years. Building on the perspective he gained through that work, he founded sustainability services company Sustento Group in 2011, which serves as program manager for the Los Angeles Better Buildings Challenge.

David has worked with a diverse set of clients, from federal, state and local governments to global lenders, investors and asset managers, utilities, advocates, national labs and affordable housing developers. He has contributed to the development of a range of industry standards and resources, including the Department of Energy's Asset Score Audit Template, the Building Owners and Managers Association (BOMA) Energy Performance Contracting Toolkit and several ASHRAE standards.

A sought-after speaker and recognized leader in the sustainable real estate world, David holds an MBA and a master's in real estate development from the University of Southern California, as well as a bachelor's in business economics from UCLA.

Hilary Firestone

Senior Clean Energy Advocate, Natural Resources Defense Council ,

Hilary Firestone is a Senior Clean Energy Advocate at the Natural Resources Defense Council (NRDC), a national non-profit working to confront the planet's most pressing problems. Hilary has over a decade of experience working on local energy efficiency policy and supporting U.S. cities to meet their carbon reduction goals. Before NRDC, she served on the Los Angeles Mayor's sustainability team where she helped develop a comprehensive strategy to reduce energy and water consumption in the city's existing buildings. Prior to relocating to Los Angeles, Hilary was a Policy Advisor in the New York City Mayor's Office of Long-Term Planning and Sustainability. There she worked on innovative energy and green building policies, including the development and adoption of the Greener, Greater Buildings Plan, and served as the New York representative to the C40 Cities Climate Leadership Group. She graduated from Cornell University with a Bachelor's Degree in Environmental Engineering, and completed her Master of Public Administration at Columbia University. She works out of NRDC's Santa Monica office.

Dan Kelley

Senior Vice President - US West, CenTrio Energy

As Senior Vice President U.S. West at CenTrio, Dan Kelley is responsible for all facets of the business associated with district systems in Seattle, Portland Oregon, Denver and (4) systems in Los Angeles, providing oversight of operations and business development. With 31 years of energy experience, he led modernization of the Los Angeles systems and is currently leading the efforts to modernize and decarbonize the district steam system in Seattle.

Prior to joining CenTrio, Dan led the District Energy practice in North America for a Danish consulting engineering firm focused on decarbonization and energy planning of district energy systems.

Allan D. Kotin

Owner and Principal, Allan D. Kotin & Associates

Allan Kotin has over 50 years of experience in real estate economics with an emphasis on financial planning and redevelopment. He has extensive experience in financial analysis, financial structuring, transaction negotiation, and market research for public agencies, developers, investors and lenders.

Mr. Kotin has been actively involved in public/private joint ventures, often acting as a key strategist and active negotiator for public agencies and private developers in major redevelopment and asset management transactions. His work includes consulting on developer selection, negotiation of public private joint ventures over a wide range of projects and extensive training and teaching experience.

Currently retired from teaching, Allan's prior teaching experience includes: Adjunct Professor, University of Southern California, Price School of Public Policy (1985-2021); Guest lecturer, Harvard University, Graduate School of Design, Advanced Management Development Program (2001 – 2011). He has a master's in economics from UCLA in 1964 and a B.A. in Economics, highest honors, Phi Beta Kappa, UCLA, 1959.

Erin McConahey, PE, FASHRAE, LEED AP

Fellow and Principal, Mechanical Engineering
Arup

Erin McConahey is a Principal in Mechanical Engineering at Arup with a current focus on multidisciplinary design leadership on project work. She is currently leading Arup's global net zero carbon buildings initiative to collect whole life carbon assessment (WLCA) data from the portfolio of work and to accelerate the use of whole life carbon as a design parameter. Her technical expertise is recognized by appointment to Fellow status within Arup and by the American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE).

Les Rosenberg, PE

Retrofit Advisor, LA Better Buildings Challenge

Active in the design and construction of large commercial, institutional and industrial real estate projects, Lester Rosenberg brings more than 40 years of engineering expertise and board-level familiarity to the LABBC. His projects have earned "Building of the Year" awards from the Department of Energy, the Governor of the State of California, Building Design & Construction Magazine, the Los Angeles Conservancy, the AIA, Southern California Edison and LADWP.

Lester has designed engineering systems for projects nationwide totaling more than 10 million square feet and have utilities planning experience that includes establishing utility systems design standards for more than 20 large central utilities plans and distribution systems across the country and four foreign nations. Furthermore, he has developed master planning and sustainability strategies for some of the largest companies in Los Angeles.

For 10 years Lester served as co-chairman of the board of directors building committee at Cedars Sinai Medical Center, overseeing an annual construction budget of approximately $100 million. He received a bachelor's in mechanical engineering from the City University of New York and is a licensed mechanical engineer in California and most other western U.S. states.

Donald R. Spivack, AICP, FRSA

Adjunct Professor, Sol Price School of Public Policy
University of Southern California,

As an adjunct professor in the Sol Price School of Public Policy at the University of Southern California, Donald R. Spivack teaches community and economic development classes at the undergraduate and graduate level. He consults on environmental justice issues with various non-profit and public entities such as the Liberty Hill Foundation, Physicians for Social Responsibility, the California Environmental Justice Alliance, Prevention Institute and both the City and County of Los Angeles. He has over 40 years of professional experience in local government, including 28 years at the Los Angeles Community Redevelopment Agency, working in urban revitalization, transportation, affordable housing, homelessness reduction and industrial development, as well as transportation and land use planning experience in Boston, MA, Philadelphia, PA, Washington, DC and Detroit, MI.

Mr. Spivack holds a Bachelor of Arts in Architecture from the University of Pennsylvania and a master's in city planning from Yale University. He is a charter member of the American Institute of Certified Planners, a life member of the Institute of Transportation Engineers, a Fellow of the Royal Society for the Encouragement of Arts, Manufacture and Commerce and is a Board Member of the Southern California Chapter of the American Society for Public Administration.

Babak (Bob) Yazdanpanah, PE

Mechanical Engineering Associate, LADWP

A professional mechanical engineer registered in California with a master's degree in Mechanical Engineering from California State Polytechnic University in Pomona (Cal Poly Pomona), Babak Yazdanpanah has more than seven years of experience with building HVAC systems, plumbing design, construction project management, energy modeling and analysis, energy efficiency and building electrification programming. He currently serves as a mechanical engineering associate within the Efficiency Solutions Engineering (ESE) group at the Los Angeles Department of Water and Power.

Stakeholder Interviews

The TAP is thankful for the commitment and participation of stakeholders. The following is a list of individuals who were interviewed to provide valuable information and perspective during the TAP process:

Martin Howell
Arup

Rebecca Becker
Equity Residential

Sarah McDowell
Arup

Pete McGing
Equity Residential

Pete Roth
Allen Matkins

Kevin Folkes
Equity Residential

Kathleen Ketrick
Buro Happold

Kirk Lumpkin
Equity Residential

Carlos Del-Cid
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Jack Martin
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Wendell Ewing
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Theis Hybschmann Petersen
ULI Copenhagen

Michael Saltzman
CenTrio Energy

David MacMillan
ULI Toronto

Austin Upton
CommonWealth Partners

TAP Participants (Left to Right): FRONT ROW: Nathalie Waelbroeck, Erin McConahey, Marty Borko, Hillary Firestone, Bethany Firnhaber, Lisa Davis, Allan Kotin BACK ROW: Cyrice Griffith, Stephen Sampson, Don Spivak, Bob Yazdanpanah, Michael Saltzman, Carlos Del Cid, David Hodgins, Les Rosenberg.

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